March/April, 1979
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Technology Review

Edited at the Massachusetts Institute of Technology

The Art of Mathematics

Saving the Nuclear Option

Sail Power for Ships at Sea

How Einstein Linked Gravity, Light, and Time

technology
review
Published by MIT

There is now a Mercedes-Benz station wagon

The new 300 TD. Before it could be a Mercedes-Benz station wagon, it had to behave like a Mercedes-Benz car.

Mercedes-Benz has engineered a station wagon that handles like – and is as solidly built as – a Mercedes-Benz car.

It does not wallow about on the road like a hippopotamus.

And it has been designed to spare its owner the aggravation of a chorus of rattles and creaks.

"First and foremost," reports *Car and Driver* magazine, "is that when you drive it empty, you very quickly forget you're driving a wagon. It handles very much like a sedan, with none of the ponderous, tail-happy lethargy we've come to expect..."

But what happens to the handling when the 300 TD is heavily loaded?

There is a sensor buried deep within every Mercedes-Benz station wagon. Should a passenger step aboard, or luggage be added, this sensor orders a special pump to send an extra supply of hydraulic fluid to the rear shock absorbers.

This raises the rear of the vehicle to its normal, most effective level.

And this, in turn, maintains the correct front-wheel geometry so that the station wagon can be steered precisely even under heavy load, instead of wallowing clumsily from side to side.

It sounds like a Mercedes-Benz car

Creaks, rattles, thrumming noises – are they the inescapable bugaboos of a station wagon?

Not so, said the Mercedes-Benz engineers.

Car and Driver agrees: "The back end doesn't sound like a crate of empty muffin tins whenever you hit a bump, which is something you can't say for your average wagon. Mercedes-Benz designers have found ways of securely buttoning down all the movable panels that usually cause station-wagon rattles..."

Good brakes are not enough

The handling ability of a car is considered of paramount importance at Mercedes-Benz. The reason is simple: if at all possible, it is always preferable to *avoid* an accident.

The new Mercedes-Benz 300 TD.
Only 2,500 will be available in the U.S. this year.

Good 4-wheel disc brakes alone are often not enough. The car must also be capable of violent evasive action without loss of control.

And so the new Mercedes-Benz 300 TD station wagon has been fitted with the sophisticated steering and suspension systems of a Mercedes-Benz car.

Steering that "talks" to you

There is zero-offset steering built into the front suspension of the 300 TD to provide more precise steering control in emergency situations.

The power steering itself has "feel." It tells your hands exactly what the front wheels are doing at every moment.

And the suspension is independent on all four wheels. Should one wheel hit a bump in the middle of a corner, that wheel alone is affected, leaving the other wheels independent to maintain their grip on the road. There is none of that alarming, sideways hop-skip-and-lurch that one expects from a less-expensive solid rear axle; the Mercedes-Benz will simply shift a few inches to one side, then smoothly resume its course.

It uses Diesel fuel. Sparingly.

The Mercedes-Benz station wagon is no gas-guzzling leviathan. For one thing, it measures a trim and nimble 15 feet 11 inches from stem to stern; it is the length of a Mercedes-Benz car. For another, it doesn't use gas at all.

The powerplant is the remarkable 5-cylinder Mercedes-Benz *Diesel.* This 3-liter engine is coupled to a 4-speed automatic transmission to achieve a balance of performance *and* economy. It delivers an estimated 23 mpg.

This estimate is from the U.S. Environmental Protection Agency. *Remember:* Compare this estimate to the "estimated mpg" of other station wagons. You may get different mileage, depending on how fast you drive, weather conditions, and trip length.

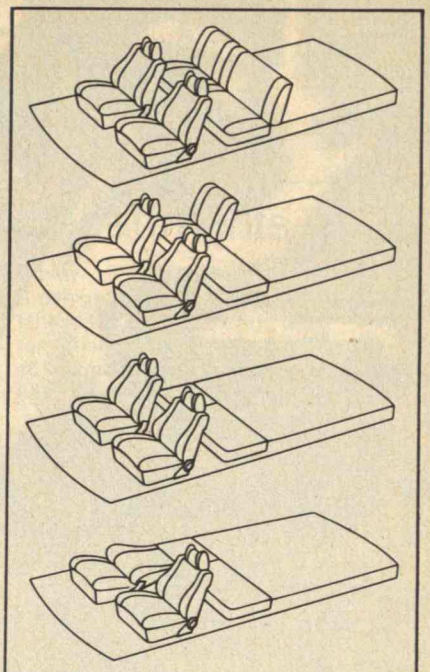
A lesson in the use of space

The interior design of the 300 TD station wagon is an object lesson in the ingenious use of space.

Raise the tailgate and look for its hinges and damper units. You'll find them tucked discreetly into the roof. It costs more to do it this way, but the Mercedes-Benz engineers wanted an absolutely smooth inner-roof surface so that bulky packages wouldn't snag on outjutting hinges.

There are seats for five adults. All of the passenger seats can be folded out of the way (*see illustration, right*) in a multitude of sizes and shapes of carrying space.

"If the object is *really* long," noted *Car and Driver,* "say a carton of record-length spaghetti or a python with rigor mortis, that's no problem either. Just unlatch and remove the right-side cushion of the second seat. Fold that side of the seatback forward. Then fully recline the passenger-side front bucket. That leaves an uninterrupted stretch from the tailgate in back to the glove-box door in front. What more could you ask?"



All of the passenger seats can be folded out of the way to provide different shapes and sizes of carrying space.

More standard equipment

In typical Mercedes-Benz fashion, the list of standard equipment is quite staggering in its length.

To name a few items: Climate control air-conditioning. Cruise control. A 4-speed automatic transmission.

Power-assisted steering and brakes. Electric window lifts.

Also, an AM/FM stereo receiver with electric antenna. A quartz-crystal chronometer. Wiper, washer, and defroster for the tailgate window. Halogen fog lamps. A pair of outside mirrors, both adjustable from inside the car.

There is even central locking: a turn of the key in the driver's door locks all four doors, the tailgate, and the fuel filler port. Simultaneously.

Engineered like no other car in the world

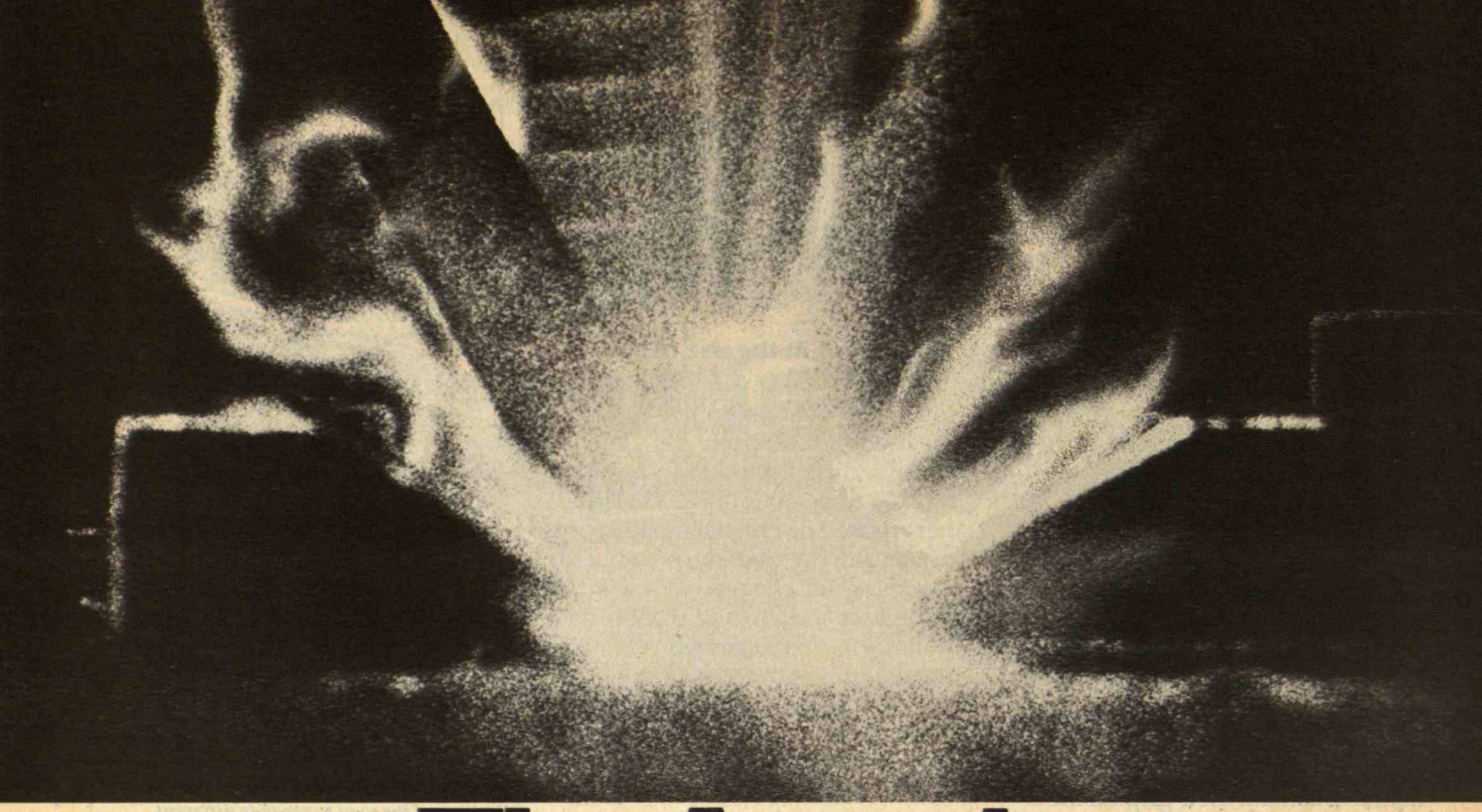
The Mercedes-Benz aim is doggedly single-minded. It is to build safe, comfortable, practical cars with as few imperfections as possible.

This philosophy puts engineering ahead of petty economies and precludes the mass production of inexpensive cars.

A Mercedes-Benz is engineered like no other car in the world.

Load this space, or add passengers, and a sensor orders the suspension to raise the rear of the station wagon to its normal, most effective level.

The alloy wheels shown are at extra cost.



The Atomic Bond.

Using tiny explosive charges, Western Electric engineers are bonding metals with the elemental "glue" of the Universe.

Here's how it works. The atoms of all metals have a natural attraction for one another. If it weren't for the ever-present film of impurities coating the surface—the oxides, nitrides, and absorbed gasses—all metal atoms would bond to each other when brought together.

Exploding Things Together.

But the force of a high-intensity explosion on two adjacent metals will clean away the film of impurities. The explosion literally "blows" the impurities off the surfaces. So the atoms of the different metals can bond together.

The bond that results is stronger than both of the metals themselves.

As an industrial technique, explosive bonding has proved valuable in the manufacture of such heavyweight products as bi-metallic gun barrels.

Pinpoint Explosions.

But how would explosives work in the delicate, intricate world of telephone circuitry?

Scientists at Western Electric's Engineering Research Center solved the problem by developing ways to miniaturize and control explosive bonding. Soon, they could splice the ends of two thin communications wires inside a miniature explosive-coated sleeve.

And they could repair tiny defective contacts on delicate circuit boards. These gold contacts (membrane-thin "fingers" 1/10 by 3/4 of an inch) are reclad by thin sheets of gold foil (.0005 inches thick), coated with explosives. The repairs are literally "blown" onto the contacts, without disturbing the delicate circuitry less than 1/10 of an inch away.

Miniaturized explosive bonding is only one way we're helping your Bell Telephone Company hold down the cost of your telephone service today. For the future, it promises the benefits of bonding widely disparate metals and all sorts of other materials.

You Can Take It For Granted.

Most important, explosive bonds are contributing to the clarity of communications, the reliability of switching, the taken-for-granted assurance you have when you reach for your telephone.

The atomic bond—it's another innovation from Western Electric.

Keeping your communications system the best in the world.

Western Electric

Edited at the Massachusetts Institute of Technology

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Articles

Departments

Welcome to an Engineer/Journalist

When he called us late last year, Steven J. Marcus introduced himself as Boston's "Mr. Sludge" of the moment: for more than two years he had devoted himself almost entirely to research on wastewater sludge management for the National Science Foundation and to a wastewater sludge composting demonstration for Energy Resources Co., Inc., where he was director of the Residuals Management Group.

The projects were ending, said Dr. Marcus. They had proved that sewage sludge from the Boston area could be composted (some 120 tons of the stuff was manufactured) and that greenhousemen, nurserymen, and public works departments could use it; hence that composting is "a potentially feasible sludge management alternative" for the Boston metropolitan area.

He would now like to return to science writing.

And were we interested?

We were indeed — in sludge management, of which more in *Technology Review* soon, but more to the point in Dr. Marcus's interest in writing. The outcome is a new name on *Technology Review*'s masthead — a senior member (managing editor) for our Board of Editors.

Dr. Marcus studied electrical engineering at City College of New York (B.E. 1965) and presently came to Harvard for graduate work in engineering, where his environmental interests seem to have flowered. After completing his Ph.D. thesis (in operations research) on "Mathematical Decision Models for Air Pollution Control Policies" (1971), Dr. Marcus worked on pollutant health effects and environmental regulation in Harvard's Environmental Systems Program, taught environmental problems as Fulbright Lecturer at the Institut d'Urbanisme of the University of Paris, and studied environmental economics and wastewater management for ERCO.

Steven J. Marcus

Meanwhile, beginning in 1971, there were free-lance contributions to the *Boston Globe,* the *Denver Post,* the *Christian Science Monitor, Environmental Action,* the *Real Paper* (Boston), *Technology Review ("Troubled Waters," February, pp. 14–15),* and others; and a book to be titled *In Harmony with Nature.*

The business of writing about engineering and its social effects pervades *Technology Review.* One who so efficiently combines the professions of engineering and journalism can hardly be amiss here, and we welcome him. — *J.M.*

Students as Authors

Though students are the central, vital element in the institution which this magazine serves, they too seldom appear as authors in *Technology Review.*

A series of three noteworthy exceptions begins with the brilliant display of modular arithmetic *(see above and page 48)* by Susan Jane Morris in this issue. Ms. Morris will receive her bachelor's degree in mathematics in June, and she hopes to proceed into business school.

Next month we'll have Michael D. Stiefel's critique of "soft energy" proposals, an article which grew from a term paper for a graduate course in energy policy. And in June will come Joseph A. Sefcik's paper on the problems and costs of decommissioning nuclear reactors when they (inevitably) wear out; it's the result of notes prepared for a seminar presentation on the same subject. Only coincidence is to read into the fact that Messrs. Stiefel and Sefcik are both doctoral candidates in the Department of Nuclear Engineering. — *J.M.*

Social Benefits of Big Science

Robert Cowen *(p.6, November 1978)* provided some useful and interesting comments on atmospheric science research efforts in the tropics (the G.A.T.E. Project). One important aspect that Cowen did not mention and that others have also frequently overlooked is the social value of such research efforts.

In December, 1977, the World Meteorological Organization held a "Technical Conference on the Utilization of G.A.T.E. Data and Its Implications for Research and Forecasting in the Tropics." As a social scientist interested in the value to society of weather and climate information, I left that meeting with rather strong feelings about the supposed social benefits from G.A.T.E.-type experiments.

There are at least two general constituencies for data derived from G.A.T.E. and experiments of similar magnitude; a scientific constituency, which Mr. Cowen represents and by far the larger one; and a social one.

The suggested social objectives of G.A.T.E. derive primarily from the potential to improve short term forecasts in the tropics and in the extratropical latitudes. As noted in the First G.A.T.E. Planning Document: "If successfully conducted, G.A.T.E. will contribute to the solution of some of the outstanding meteorological problems of our time which, in turn, may result in tangible economic benefits of major significance."

Though the G.A.T.E. experiment hopes for such a social contribution, some important questions have not been asked. For instance, given the relatively long lead time between the G.A.T.E. experiment and the expected improvements of forecasting in the tropics, what might a society do to prepare itself for the best possible use of such forecast when it does become available? And what changes, if any, would one make for future G.A.T.E.-type experiments in order to further enhance the scientific as well as the social value of the experiment?

I believe the results of such an investigation might identify potential obstacles to the effective use of such weather information for which society can prepare.

From the standpoint of social value, most would agree that a major reason behind the development of an improved forecast is to increase food and fiber production for domestic consumption as well as for export. Yet a recent study on "The Social Value of a Long Range Weather Forecast for the West African Sahel" (Glantz, *Bull. A.M.S.,* February, 1977),

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suggested that much could be done *now* to improve agricultural production in the Sahel and that many obstacles to the efficient use of weather information are social in nature. This may be valid to varying degrees for other tropical regions as well. While the impact of adverse weather-related anomalies may be great, the mitigation of those impacts on society might be found in the social realm and not necessarily in the scientific one. Yet scientific experiments are often relied on to solve problems which can only be solved in the social realm.

Additionally, there is a divergence between the view Mr. Cowen records and the "off the record" view given by many of those familiar with G.A.T.E. For example, participants at the W.M.O. technical conference publicly noted the importance of that meeting. Privately, some suggested that the conference was many years too early to consider the utilization of G.A.T.E.-derived data while others suggested the conference was too late and should have been part of the G.A.T.E. planning phase. This kind of input should be made explicit so that planners of future G.A.T.E.-type experiments can benefit. One might recall the Chinese proverb: "To know the road ahead, ask those coming back."

Finally, given the scarce monetary resources available for scientific research and for social problem-solving, I suggest that future G.A.T.E.-type experiments should have a social task force component to investigate how the results of such experiments might best be used to cope with social problems. It will become necessary to make difficult decisions about G.A.T.E.-type projects: should they primarily be applied or basic research, for whose benefit, for short- or long-term payoffs, etc. Perhaps for such "big science" projects as G.A.T.E. an effort should be made in the future to stress the distinction between what scientific information is desirable and what is possible, what is desirable and what is essential. This will become increasingly important as desirable projects (as seen by one constituency) are in competition for funds with essential projects (as seen by another constituency).

Michael A. Glantz
National Center for Atmospheric Research
Boulder, Colo.

How Much Nuclear Waste?

In your issue for November *(page 24)*, Odile Disch writes that the U.S. now has in temporary storage "some 9.4 million cubic feet of high level wastes from the U.S. weapons program and 112,000 cubic feet of high level nuclear wastes and spent fuel from civilian power reactors. The volume of the civilian wastes is already equal to the total produced by the entire weapons program. . . ."

The second statement, which contradicts the previous sentence, is incorrect; the figures given are taken correctly from the report cited later in the article — that of the Interagency Review Group.

As of last year, data available show that the military wastes are significantly larger than commercial wastes in terms of volume, perhaps 90 to 100 times greater. In terms of radioactivity, the military high level waste is still twice as great as the commercial high level waste. It appears that commercial high level waste activity will not equal or exceed military levels until after the year 2000.

Francis J. Wiedenmann
Boston, Mass.

Mr. Wiedenmann is Manager of Nuclear Information in the Public Information Department of Boston Edison Co. He is quite correct in calling attention to the mischief wrought by a gremlin in our typesetting of Ms. Disch's report; her manuscript was entirely correct, quoting Hartmut Krugman and Frank von Hippel in Science *(August 26, 1978) to say that "the radioactive content (of the wastes produced by commercial reactors) is already equal to the total produced by the entire weapons program, and by 1985 the amount of civilian nuclear wastes will increase each year by an amount equal to the total military inventory of nuclear wastes." Responding to Mr. Wiedenmann, Ms. Disch notes that there is "tremendous disagreement" in predictions of future volumes of high level waste. Many different measures are used; the amounts of waste being added by military and civilian sources are not easily determined, nor are future additions easily estimated. Indeed, says Ms. Disch, "predictions on the future of nuclear wastes vary widely according to ones's position toward nuclear power."*

The editors apologize to our readers for having further complicated this already sensitive and complex subject and to Ms. Disch for having rendered her report confusing and inconsistent. — Ed.

Relativity of Convenience

Joan Baum's good review of Karl Menninger's *Number Words and Number Symbols (August/September, 1978, p. 72)* contains a common misconception of Roman numerals. They were not a "crude alphabet system of notation," but a coherent set of symbols satisfactorily illustrated and explained in Menninger's book; and though the Roman notation is "cumbersome" for those who calculate with pencil and paper, it is not "confusing," but a clear, direct, and convenient system for those who use an abacus or a counting board.

L. A. MacKay
Kensington, Calif.

Responsibilities of Scientists

In your August/September, 1978 issue, Robert Cowen expressed outright concern that certain scientists were working with public interest groups; Kenneth Boulding, president-elect of A.A.A.S., questioned his organization's stance of participating in the E.R.A. boycott.

Both these articles are perfect examples of how scientists set themselves apart from the mainstream of public life. In each case these men rationalize that scientific activity should stay in the laboratory.

As one who works with scientists through my job on Capitol Hill, I am grateful to those who are able to assist policymakers in our increasingly complicated decisions. If it were not for the scientists working with public interest groups, this knowledge would never become part of the policymaking process.

Wake up, Mr. Cowen and Mr. Boulding! You are American citizens as well as scientists and you have responsibilities as a citizen to your fellow people of this world.

Scott Sklar
Washington, D.C.

Energy from the Ocean

The interesting article "OTEC: Electricity from the Ocean" by William F. Whitmore in your October issue, omits an important site in the map of page 61.

As I have pointed out in the short story "The Shining Ones," there is an ideal location for an Ocean Thermal Power Plant at Trincomalee on the east coast of Sri Lanka. A deep canyon approaches to within a few kilometers of the land and in fact the 3,000-foot depth is only three kilometers from the shore at one spot. Obviously, a land-based installation has enormous advantage over an oceanic one.

Arthur C. Clarke
Colombo, Sri Lanka

(Letters continued on p. 18)

Pay Up... Or Be Fired.

Giles Breaux is a highly decorated ex-GI who fought against tyranny and for freedom in World War II and the Korean War. Today he's fighting again—for his own personal freedom.

This time the battlefield is the California farm where he works—his opponent is Cesar Chavez, who rules the members of his United Farmworkers of America with an iron hand.

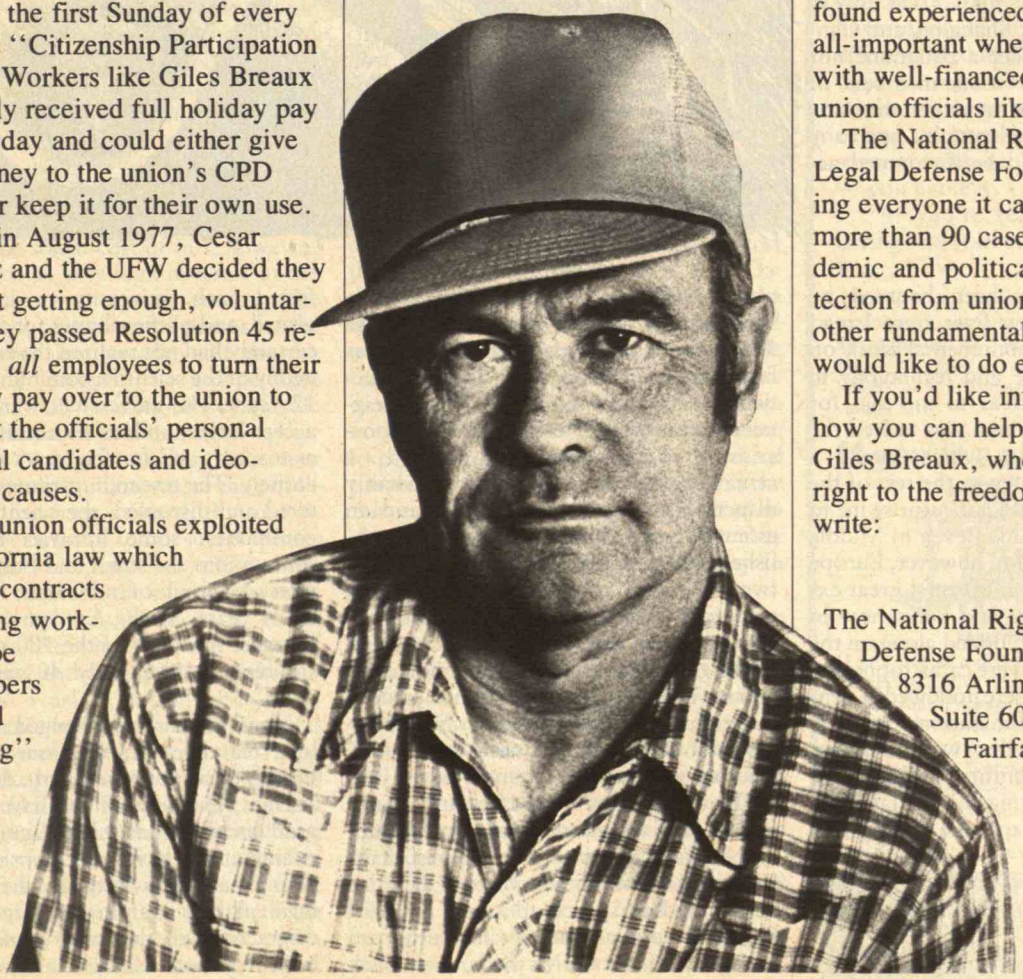
UFW contracts with employers reserve the first Sunday of every June as "Citizenship Participation Day." Workers like Giles Breaux formerly received full holiday pay for the day and could either give the money to the union's CPD Fund or keep it for their own use.

But in August 1977, Cesar Chavez and the UFW decided they weren't getting enough, voluntarily. They passed Resolution 45 requiring *all* employees to turn their holiday pay over to the union to support the officials' personal political candidates and ideological causes.

The union officials exploited a California law which allows contracts requiring workers to be "members in good standing" of a union to keep their jobs. And the union is the sole judge of a "good" member.

The UFW warned Giles Breaux to turn over his holiday pay or run the risk of being declared a member not in good standing. Breaux's answer was to the point: "I have a right to do what I want to with my money." He refused to pay up, and was immediately threatened with being fired.

That's when the National Right to Work Legal Defense Foundation stepped in and filed suit on behalf of Breaux and 11 other members of the UFW. The Chavez union was charged with oppression, fraud, malice, and violation of the workers' constitutional rights. The suit also asked the court to strike down the California law that allows the union to have absolute power over workers by requiring full union membership as a condition of employment.



Giles Breaux was fortunate. He found experienced legal help—all-important when you're dealing with well-financed power-hungry union officials like Cesar Chavez.

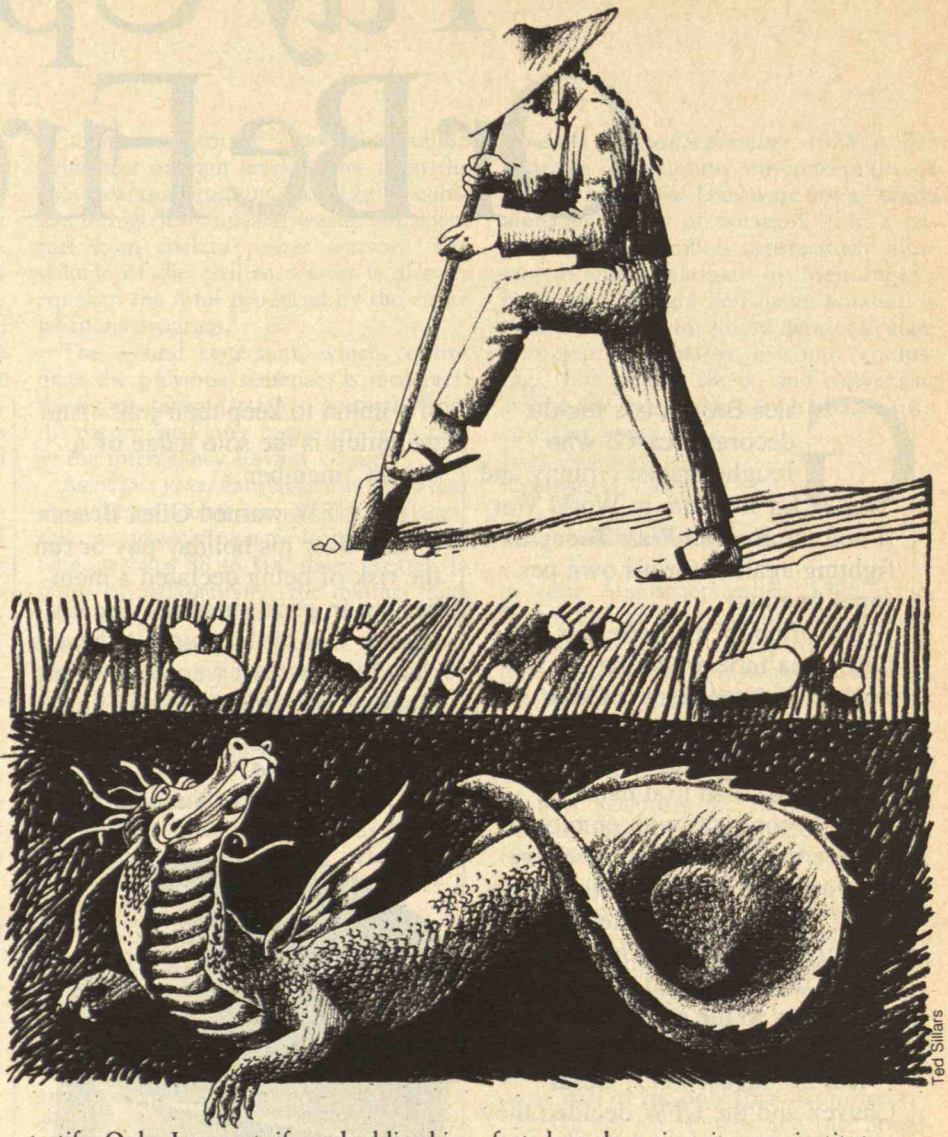
The National Right to Work Legal Defense Foundation is helping everyone it can—currently in more than 90 cases involving academic and political freedom, protection from union violence, and other fundamental rights. But it would like to do even more.

If you'd like information on how you can help workers like Giles Breaux, who says, "I have a right to the freedom I fought for," write:

The National Right to Work Legal Defense Foundation
8316 Arlington Boulevard
Suite 600
Fairfax, Virginia 22038

China Unearths Flowers and Dragons

Kenneth E. Boulding is Director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review.



Ted Sillars

I had the very good fortune to be a member of the Board of the American Association for the Advancement of Science which visited the People's Republic of China last November at the invitation of the Scientific and Technical Association of that country. It was a remarkable experience to be there during this period of profound change. Essentially we visited the scientific community in China, its universities and research institutes. I was only in three cities — Peking, Shanghai, and Canton — and saw neither a commune nor acupuncture, though some members of the party did, so that my experience was an extremely limited sample, and any generalizations should be discounted accordingly.

Opening Old Doors

My imagination has been haunted by China for many years. Ever since I read Joseph Needham's monumental work on the history of science and technology in China, it has been clear to me that for almost 2,000 years China was indeed the middle kingdom from which spread a great deal of technology to the rest of the old world, and it would not surprise me to find traces of early China even in Middle America. From 1500 on, however, Europe and its extensions took off on a great expansion of knowledge and know-how in science, while China plodded along on the old path. The results were catastrophic for China. After 1840 there followed a century of invasions, humiliations, internal war (the Taiping Rebellion was the largest war of the 19th century in terms of casualities), culminating in the Japanese invasion, civil war, and the triumph of Mao Tse-Tung in 1949, which everyone in China referred to, I was fascinated to observe, not as a revolution but as a liberation.

A period of extraordinary social change ensued, to which all the old China hands testify. Only, I suspect, if one had lived in what is now Mexico City from 1520 to 1550 would one have seen a change as large as that taking place in China between, say, 1940 and 1970. The foreigners were expelled, the landlords dispossessed, communes organized, a centrally-planned but still remarkably dispersed economy was created, and an essentially new religion of Maoism established. We visited Mao's tomb, a cross between the Lincoln Memorial and the Ming emperors' tombs, filed in the endless line of people past the huge statue and behind to the glass case containing the mortal remains. There was perfect silence, a deep sense of respect and reverence. Now I understand the tomb is closed for repairs. Another great change is underway.

The atmosphere in the scientific community that we visited could only be described as springtime after a long, hard winter. Everywhere we went we heard a fairly standard speech about the Gang of Four and how, as one of our interpreters said, they tried to drive the country back to feudalism. We were told how this affected each university or institute we visited, and of their hopes for the future. I certainly had not realized the extent of the agony of the scientific community of those 12 years. The universities were forced to accept large numbers of untrained people as teachers and for five years were closed entirely. The research institutes were scattered and dispersed, the scientists sent to communes; some libraries had books thrown into the street and burned, others were deprived of additions for a good many years. At the Academy of Sciences we were told that of the 100 research institutes in 1966, only 40 remained by 1976.

Now, all this has changed and a new, long march embraces "four modernizations": agriculture, industry, defense, and science. The universities have reopened, graduate work has started again, entrance examinations have been reinstituted. The young man who was made a hero for turning in a blank examination paper has been disgraced. Ten thousand students are to be sent abroad. Libraries are to be rebuilt. Visiting lecturers are in great demand. The

door to the whole capitalist world is wide open. Everywhere we were received with warmth and friendship. We established a delightful personal rapport with our Chinese scientific colleagues and shared in their joy to reenter the world scientific community after this long imprisonment. Our group concluded an informal agreement with their Scientific and Technical Association to foster future exchanges; a Chinese delegation will come to the United States in May and we both hope a considerable scientific exchange will develop.

Fragile Social Tundra

There are still puzzles and worries. I can make no estimate of the stability of the present regime. One of our members asked our guide and interpreter why there were so many soldiers in Peking, with all the bridges and public places guarded with armed men? He smiled and said, "Well, there is still a class war in China." The Cultural Revolution certainly was a class war, which was lost by the people who made it. The official term for the Red Guard now is "hooligans and illiterates." We asked what was going to happen to this lost generation of young people, but nobody really knew. Mao produced a society of what might be called "decent poverty," which certainly seems better than the society of indecent poverty which preceded it. The social cost of this, however, impresses me as very high in terms of the total politicization of the society, the enormous concentration of power in the hands of very few people, and the destruction of virtually all independent sources of morality and legitimacy outside the state, the party, and the army.

To use a biological analogy, one sees China as a social tundra, where the political climate has been so harsh that only a small number of very tough social species have been able to survive very close to the ground; by contrast, the capitalist world, represented by, say, Tokyo or Hong Kong, seems like a lush tropical forest of overwhelming and perhaps even pathological variety. I asked, for instance, how many churches were open in Peking and was told there might be two. In Hong Kong I peeked in the classified telephone directory and found five pages of churches of every conceivable denomination in a city of only four million. The tundra, however, is fragile and unstable. A little warming in the atmosphere and the birch trees invade it silently one by one. And a very different ecosystem emerges. One wonders if this will not now happen in China. In Peking we saw an exquisite fairy story ballet, banned during the Cultural Revolution, a sheer aesthetic delight with no political implications or propaganda. One hundred flowers are blooming again, but how long will they bloom?

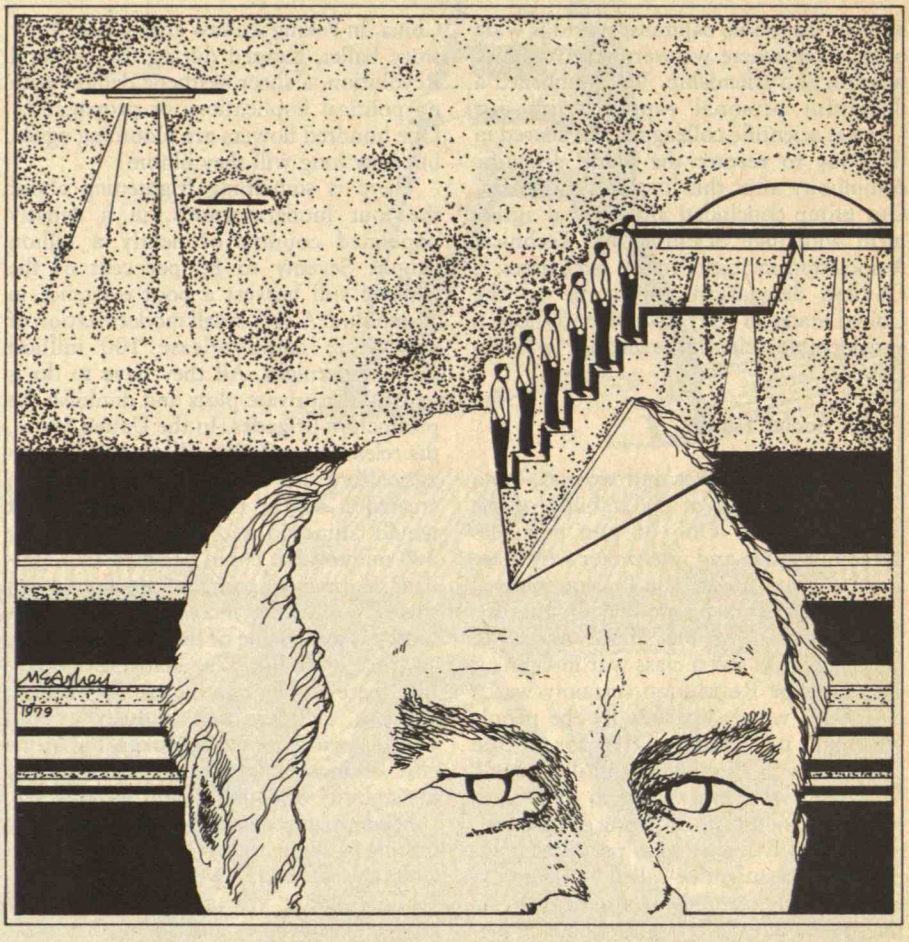
There is something frightening about the four modernizations, in a densely populated country of nearly a billion people. Seventy to 80 per cent of the Chinese still harvest a poor existence in agriculture. A very small modernization of agriculture could release 100 million people overnight. All they have to do is expand the private plots and diminish the production brigades. In the United States, the release of only 30 million people from agriculture in the last generation has created a severe urban problem. What would China do with the 100 million or 200 million that could be so easily unsettled? In time, of course, they can be absorbed producing increased riches, even bicycles, for in spite of the fact that Peking swarms with bicycles, statistics suggest that there is only one bicycle for each 30 Chinese. Modernizing industry could produce ten more Hong Kongs, but at the cost of increasing inequality, disturbing the stability of equal, decent poverty.

Modernizing defense is even more disturbing. Peking today looks almost like Germany of 1937, with army convoys, soldiers doing the goose step, armed guards everywhere, and so on. The vast underground defense installations suggest that China is expecting a nuclear war. The deep sense of betrayal by the Russians, the fear of Russia, creates an international tension that reminds one of the Middle East. If China modernizes its defense, this increases the arms race and it puts Russia in the pincers of East and West, which is likely to produce the same kind of paranoia that we found in Germany in the thirties, that will almost inevitably lead to almost unthinkable catastrophe. One found no sense in China that one way to modernize defense is disarm.

Of the four modernizations, the modernization of science is the easiest. There are only 30,000 scientists in China. In ten years they can rejoin the world scientific community. The great question, however, is whether China can do this and still preserve some of its unique heritage. Can it lessen its poverty, and increase its freedoms and its cultural variety, without abandoning its commitment to the principle that no poverty shall be indecent? There is no doubt China has a lot to learn from us, and that we have something to learn from China — if we can only find out what it is. □

Explanations of the First Kind

Robert C. Cowen, Science Editor of the Christian Science Monitor, *is former President of the National Association of Science Writers and is a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*



M. Earley

This year opened with yet another flying saucer "mystery." Glowing spheres were seen over New Zealand. They played tag with aircraft. They made blips on radar. They were even filmed by an Australian television crew whose fuzzy photos intrigued TV viewers and newspaper readers around the world. And, true to the U.F.O. observer tradition, the pilot of the TV plane, commenting on the light he saw, said: "It appeared to stay still until we got within ten miles, then it turned with us as we changed course. It then went above us, circled, and came down beneath us. It was making definite motions in relation to us." On two nights, December 22 and 28, such sightings were vivid enough to warm a U.F.O. buff's heart. Why then heed the skepticism of meteorologist Neal Cherry of Christchurch, New Zealand, who subsequently pointed out that the flying lights and radar echoes were most likely anomalous, but quite natural, atmospheric effects? Why indeed, when it is more fascinating to have a mystery with overtones of extraterrestrial visitation than it is to accept that science has a natural explanation for such things?

Varieties of Perception

Such rejection of reasonable explanation by many people is one of the most puzzling aspects of the on-going phenomenon of flying saucer sightings. In saying this, I'm not referring to the truly "unidentified" flying objects — the sightings with too little evidence to go on or that otherwise puzzle serious saucer investigators. I'm talking about the great majority of U.F.O.s that, like the New Zealand lights, may seem puzzling at first but that are open to subsequent explanation.

According to a report in *New Scientist*, Dr. Cherry pointed out that on the nights of the sightings the sea was overlain by a thick layer of cold moist air topped by a flow of dry, warm air from the northwest. He called the conditions "classic" for bending radar beams to produce spurious targets and for refracting surface lights into the air. He suggested that the visual U.F.O.s could well have been the lights of a large squid fishing fleet that was operating on those occasions. More recently the Department of Science and Industrial Research of New Zealand said that the flying saucer was almost undoubtedly Venus. After analyzing the photographs taken by the television crew, they concluded that the out of focus object was made to appear ten times larger than actual fact. Such explanations are likely to leave U.F.O. buffs cold. A friend of mine who is otherwise an astute and critical news reporter brushes them aside. He wants so much to believe in alien star ships that he abandons his normal professional skepticism of weak evidence and accuses scientists such as Dr. Cherry of being close-minded.

This is typical of a widespread and apparently deeply seated psychological tendency throughout the world today. Hershel W. Leibowitz of Pennsylvania State University, an expert on the psychology of perception, is interested in the influence this tendency may have on the actual U.F.O. sightings themselves. He notes that "people have a great penchant for looking at the sky and getting excited about things they don't understand. This impulse is magnified by the fact that perception isn't straightforward. It's selective, often unconscious, and greatly influenced by what we want to see."

People can be fooled by what goes on within the eye itself. Phenomena within the eye can appear as strange lights or shapes in the sky. Dark, darting shapes seen against a clear, bright sky can be tiny objects floating in the eye liquid. Moving lights in a dark, night sky can be just the result of high visual sensitivity. Dr. Leibowitz explains: "Almost everyone has floaters, and most people, at one time or another, will see nonexistent lights. Some people are just more sensitive to these phenomena, just as some are more ready than others to see 'unexplainable' sights. Couple these possibilities with the fact that someone gazing at a very bright or dark sky devoid of visual stimuli has great difficulty judging depth, size, or speed of an object, and you have a possibility for many U.F.O. sightings. Essentially the more impoverished of stimuli a situation

is, the more an individual's desires, sometimes enhanced by entopic [within the eye] factors, can influence perception. The blacker or brighter a clear sky is, the more chance there is for someone to see something that isn't there."

Atmospheric Tricks

When the atmosphere can also play tricks on observers, you have a perfect set-up for seeing flying saucers. Penn State meteorologist Alistair B. Fraser, an expert on mirages, shares Dr. Leibowitz's interest in saucer sighting. He points out that the atmosphere has far more optical effects than most people would imagine. He explains: "When distant objects are viewed near the horizon, the atmosphere can create major distortions and present normal objects in abnormal ways. The atmosphere is acting as a lens so that we don't see the objects but rather their altered 'images.' By acting as a lens, the atmosphere can magnify an object, make it smaller, cause part of a scene to vanish, or produce images [of objects] that aren't there but that are 'real' enough to be photographed or to be picked up by radar." He adds that "some of the flashing colored lights people report seeing in the sky are caused by the atmosphere separating the reflected lights from stars into rainbow colors, and making the lights seem to jump around and change colors . . . if closely observed, stars 'twinkle' in colors."

Yet another deceptive effect is that of the "infinitely" distant object or light that seems to be giving pursuit. "Just as the moon appears to move with us or to 'chase' us when we're riding in a car or an airplane, so too do lights or objects in the sky seem to be following us," Dr. Fraser says. "The reason is that, if we perceive an object as being close to us that actually is infinitely far away — the way we perceive the moon and the stars — the object assumes motion as we ourselves move."

Electrified bugs may represent another atmospheric cause of U.F.O. sightings. Last fall, U.S. Department of Agriculture biologists Philip S. Callahan and R. W. Mankin reported that mass flights of the spruce budworm moth could have been the source of nocturnal lights seen over northeastern Utah from 1965 to 1968. Flying through relatively strong atmospheric electric fields, such as those around thunderstorms, the insects could acquire enough induced voltage to give off coronal discharges such as the St. Elmo's fire that flashes from church steeples, ship's masts, or aircraft wings. Drs. Callahan and Mankin produced spectacular discharges in their laboratory. They used a variety of insects which seemed none the worse for the experience. Flares of light around the bugs flashed in several colors with the blue of nitrogen radiation predominating. Callahan and Mankin conclude: "There is absolutely no doubt at all that, given the right weather conditions, nature can produce a high enough electric field to light up flying insects."

Such weather conditions would also encourage mass flights of certain insects such as the spruce budworm moth which infested the region of the Utah sightings. The swarms typically can be 100 kilometers long by 25 kilometers wide. Concentrations of insects within such swarms can be dense enough and sharply edged to look like solid bodies. Coronal discharges from these concentrations could seem to be lights of some machine, while the buzzing sounds and erratic movements reported for some U.F.O.s are typical of insect swarms, the two biologists note.

In making such points, scientists such as Callahan and Mankin or Leibowitz and Fraser aren't trying to put down the possibility of alien visitations. All four specifically said that star ships may indeed visit Earth. But they do emphasize that the atmospheric and perceptual phenomena they describe can fool the best of observers. Given the propensity of many people to want to believe in flying saucers anyway, they stress that a great many sightings can probably be explained in these terms.

Emotional Overdrive

This still leaves the puzzle of why people refuse to accept such explanations, especially in cases when these are much more plausible than the so-called "extraterrestrial hypothesis." Allen Hendry, editor of the *International U.F.O. Reporter,* has described a particularly blatant instance that occurred around Aurora, Illinois.

On the evening of April 29 last year, dozens of people saw a classic flying saucer with a dome on top and surrounded by rotating lights. Some said it passed close overhead. It turned out to be an advertising plane with a battery of lights that spell out messages. Mr. Hendry has identified such planes with some 300 U.F.O. reports telephoned to his office. In most cases, people don't see what is clearly there to be seen. They insist they see a disc-shaped craft with a dome on top. This is in spite of the fact that the flights of the planes are a common occurrence.

(Continued on p. 83)

A Future Beyond Push-Button Careers

Warren G. Bennis has been watching people and their organizations ever since studying for his doctorate in psychology (1955) at M.I.T.'s Sloan School of Management. He's now living in Aspen, Colo., planning a new career after 20 years in academic administration at the State University of New York at Buffalo and the University of Cincinnati (President, 1971–77).

Q: "What kind of work do you want to do when you finish school?"
A: "I want to be an astrophysicist."
Q: "Do you want to do that the rest of your life?"
A: "No, I'd get bored."
Q: "Then what would be your second choice of a career?"
A: "Well, then I'd like to be a comedian."

I think this 12-year-old boy has succeeded in his second career already, without half trying. I got these answers recently, when, armed with a video camera, I went into several schools to ask the kids about their concepts of work and careers. One prod to my exploration of this subject was a film highlighting my presidency of the University of Cincinnati made by the alumni association. In one sequence, cameras zoomed in on my three young children, and a voice asked: "What does your father do?" Obviously my eight-year-old son was impressed with my position: The most important aspect of my job to him was the occasional presence of a university-owned car that took me to work and home again. His on-camera response was that his Dad sat in the Oldsmobile all day pushing buttons, raising and lowering the electronically controlled windows.

I had been researching and talking to adults about careers and work for years. But that episode sent me out to find out from kids what they wanted to do with their work lives.

A fascinating aspect of these filmed interviews is that the children's responses confirmed most of the large-scale studies on workers' attitudes toward work. For example, of the 50 kids I interviewed, only one or two had any real idea of what their selected work would entail. But more important was the fact that virtually none of the young students — from kindergarten through grade 12 — even considered the traditional job markets. Forget manufacturing or mining. Moreover the service industries were entirely ignored. Nobody wanted to be a doctor or a dentist, and not one aspired to running a franchise operation — even MacDonald's.

Astrophysicists, comedians, ski instructors, stunt pilots were the most concrete jobs mentioned. The rest of the kids seem to think the job market consists of a giant film studio sprawling from Boston to L.A.; or recreational parks featuring thousands of country-western and rock groups, supported by the profits from the world's most conglomerate of conglomerates: soft ice-cream manufacturers, hi-fi stores, sporting goods emporiums — all based in someone's backyard like a cottage industry.

Following this revelation, I was further puzzled when, on New Year's Eve, I heard on a local radio station several interviews with officials under 30 years of age who were working in responsible jobs for city and county government. They were asked about their New Year's resolutions. The manager of the local air field answered: "I want to make sure that my trip is successful this coming year." Asked to elaborate, he said, "Well, you know, I want to keep a good high all year." The next respondant was the assistant finance director for the county who said he wanted to reduce in 1979 the number of *est* courses he took. "How many did you take in '78?" asked the interviewer cheerily. "Eleven," was the response. I quickly switched off the set.

Company vs. Compatibility Ethic

A recent survey of work attitudes of more than 3,000 men and women in 53 companies is somehow consistent with what the kids and young officials said. The study, conducted by a team of organizational psychologists from Brigham Young University, found that among those workers in the oldest groups they studied (ages 40 to 65 and 27 to 39), the traditional Protestant work ethic was alive and well. The youngest workers (17 to 26) however, turned out to be less satisfied with their jobs, the company, management, pay, and just about everything that moved. Older workers felt that "the community was a better place to live because of the company." Not so with the young. Another striking difference the researchers found was that older workers felt "it is more important to work hard than to get along with your friends," while the young workers felt quite the opposite was true.

The researchers concluded: "Older workers had their attitudes shaped by the hard times they experienced during the Depression and the patriotic incentive that led them to work diligently during World War II. . . . Older workers were taught the 'character ethic' in their homes and schools, whereas younger workers were taught the 'personality ethic.' . . . The former holds that the way to success and wealth is through hard work, frugality, industry, diligence, prudence, and honesty. The personality ethic, in contrast, teaches that the way to success is through other people: success comes from a pleasing personality."

I admit to having some trouble with the interpretation of the study: I have not found, as a rule, that "young workers" of my acquaintance are notable for their "pleasing personalities." And it also strikes me that my own as well as my father's generation were clearly influenced by the Dale Carnegie brand of bone-crushing hand-shake, toothsome smile, and the cheery disposition immortalized in Willy Loman of "Death of a Salesman."

Still, other findings are consistent with those reported by the Brigham Young team. Daniel Yankelovich's surveys tend to be reliable, and his interpretations are almost always sound. He recently reported that one out of three people in the nation expects his or her work to be psychologically fulfilling, as well as economically rewarding. For the young (and better educated), the statistics go way up "to more than 50 per cent," according to Yankelovich; "for the older, less well-educated people, they go down to around 22 per cent."

Outside the System

The catch-all phrase "psychologically rewarding" becomes clearer in the words of Nancy, a recent graduate of a fine college, the daughter of affluence, and of my friends. Nancy writes to me from "the boonies" periodically, where she earns her keep waiting on tables in a country lodge.

"Dear Mr. Bennis," she writes. "I've been thinking of leaving the lodge. Wow, but there's a lot behind that statement! But I have no idea where I'd go. It seems like I need to try a profession. . . ." But, she says, she likes it where she is: "I really like the quiet and the smell here. I like being able to run every morning in cow pastures with dogs. I like having my own hours with lots of free time. I like living

and working with a lot of other people. . . . But it seems I need more purpose — more goals."

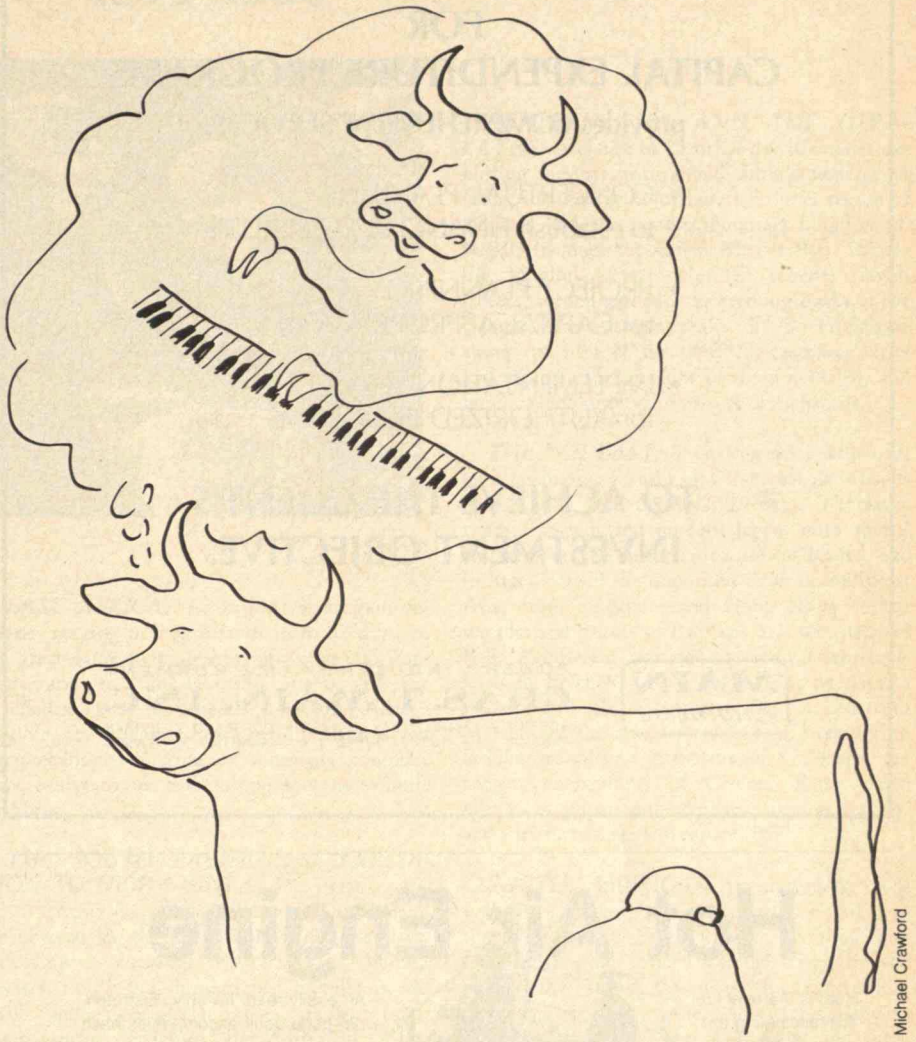
In a later letter, Nancy goes on to talk about choosing a profession: "I decided that I wanted to work with people not statistics; with spirituality, not intellectuality; with getting people in touch with their souls, and hence with their bodies. I came up with two job ideas. One, the ministry, where working with individuals would be inherent in my job. I realize that the ministry involves a lot of bureaucracy as well, but it won't be close to the main focus of the job. The second idea is to be a yoga teacher. I definitely see yoga as drawing oneself closer to self-consciousness, as well as realizing a common universal among people — all in all, being closer to your soul, more in touch with your body, more at peace with yourself and hence with others."

Nancy, moreover, goes on to chide me for my decision to work on making large corporations more livable for the employee: "My immediate reaction is *why?*" she writes. "Why support that type of lifestyle at all? Why work on making the dehumanizing institution slightly less so? Why support that system at all? The analogy that pops into my head concerns the atom bomb. When it first appeared, people asked the question of how to use it, instead of whether it should exist at all: Now, large corporations are here to stay, as is the atomic bomb, and perhaps toiling with the problem of living with these two monstrosities is more realistic, but the broader question of their *actual existence* seems more important."

I answered Nancy with a few banal comments about how lucky she was to have a choice, and that I was happy she was making one; that choices are scary — though less so when is young. But I chewed on her a bit about her starry-eyed infatuation with wilderness chic, and I told her I was losing patience with young people who think that the solution to the dehumanizing workplace is to abandon it.

"Do you really believe," I wrote, "that 'one dehumanizing workplace' is something you order from a Sears catalog? It has to be tolerated or changed by humans who made it that way in the first place. I have very low tolerance for your brand of non-involvement, your scorn for the system. Outsider, special interest, or adversary postures may be as ego-gratifying as all get out, but I'll be damned if I've seen much significant social reform getting accomplished that way."

I went on to say that when I hear of her and others falling victim to that debilitating virus of self-pity (the reciprocal of blaming "the system"), I feel as helpless as she must feel with the prospect of ever taming that contemporary Moloch. All her dreamy desires (and mine), her lofty goals (and mine), her splendid value commitments (and mine), will turn to dust and blow away unless we bring to them a decision to work as hard as people have ever worked in their lives — far harder than waiting on tables in the "boonies."



Michael Crawford

Detente Between Diverse Futures

I am not satisfied with my answer; it abounds with admonition and advocacy as substitutes for explanation and inquiry. I like to think that next time I will say something about the changing meaning of success and achievement in "our times" and how the value we give to work has everything to do with our notions of the future. It seems to me that there are at least two futures moving simultaneously in our culture. There is the Bell, Toffler, Galbraith view of the "post industrial" future, running concurrently with Nancy's "meaningful outsider" view.

In the post-industrial view, success depends on at least a baccalaureate degree, and those who make it "big" will possess a Ph.D. from one of the "best" universities. Working institutions will be service-oriented, and problems caused by science and technology will be solved by a higher order of technology. Philosophers will indeed be kings, as society gets bigger, more centralized, more efficient. We will be able to solve certain social problems, but the main emphasis will be on employment and growth. The other future is one suggested, in a diffused way, by Nancy and other young people whose highest good appears to be personal growth, autonomy, choice, and interpersonal relationships.

In summary, the post industrial future can be characterized by: material growth, man over nature, competitive self-interest, rugged individualism, large is beautiful, identity defined by patterns of consumption and work status, specialized work roles, standardized products, and stressful existence. On the other hand, what I term "voluntary simplicity" seeks a future of material sufficiency, man within nature,

enlightened self-interest, cooperative individualism, small is beautiful, identity found in interpersonal discovery, integrated work roles, unique products, and a relaxed existence.

I suspect that both these futures exist, posing a dialectic that makes it difficult, and perhaps foolhardy, to assume a continuum with our generation and the next in terms of values and work.

The '60s churned our country up like no other decade that preceded it, and while quiet and docility now pervade campuses and major institutions, we are going through difficult readjustments. Despite the rhetoric, our country is going neither to the left nor to the right. We are not becoming reactionary or radicalized. We are in transition, responding to problems ambidexterously — right, left, left, right.

Until a more workable detente is reached between the two primary "futures" I described, I suspect that for young people "taking time off," some inward immigration, and waitressing may not be an altogether dreadful thing. Another reason I say this is that it is not easy these days to find a job that is even "economically rewarding," let alone "psychologically fulfilling." Job opportunities are frighteningly limited, and frequently non-existent. Ph.D.s are working on road construction teams; M.A.s are typists and clerks — if employed at all. Rock stars, ball-players, TV personalities are working steadily and hauling in half a million dollars a season. One can hardly fail to understand why kids cultivate the "personality ethic."

Rollo May said not long ago that without new possibilities there can be no conflict; there can only be despair. By taking a good look at both futures in our midst, allowing young people to define what "success," "progress," and "psychologically rewarding work is to *them,* and discarding the assumption that our hard-earned work ethic is good enough for our kids because it was good enough for us, may help relieve some of that despair out there among unemployed young people; may open new possibilities for them.

Astrophysicist or comedian; minister or yoga teacher? Yes, the choices sound weird — and the choosers ambivalent. My young son may have summed up my life's work as pushing buttons in an electronically controlled automobile, but I have no way of predicting what his life's work might be. This is not altogether unfortunate, I think, for it allows for new possibilities in work which are now inconceivable to me.

In our time, ambivalence is appropriate; remaining open to redefinitions is necessary; admitting of a future that is unlike the past is essential — as long as we keep in mind the admonition of that guru of the "Beat Generation," Jack Kerouac, who was more meticulous with his insights than with his metaphors: "Walking on water wasn't built in a day." ☐

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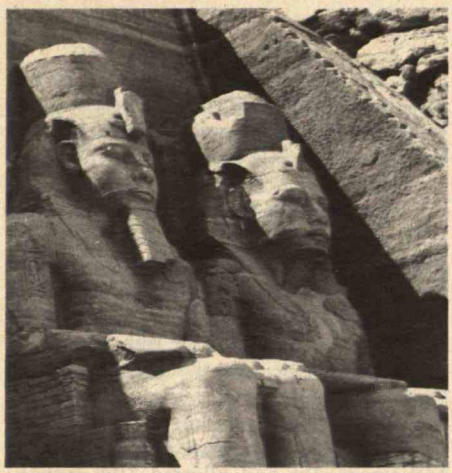

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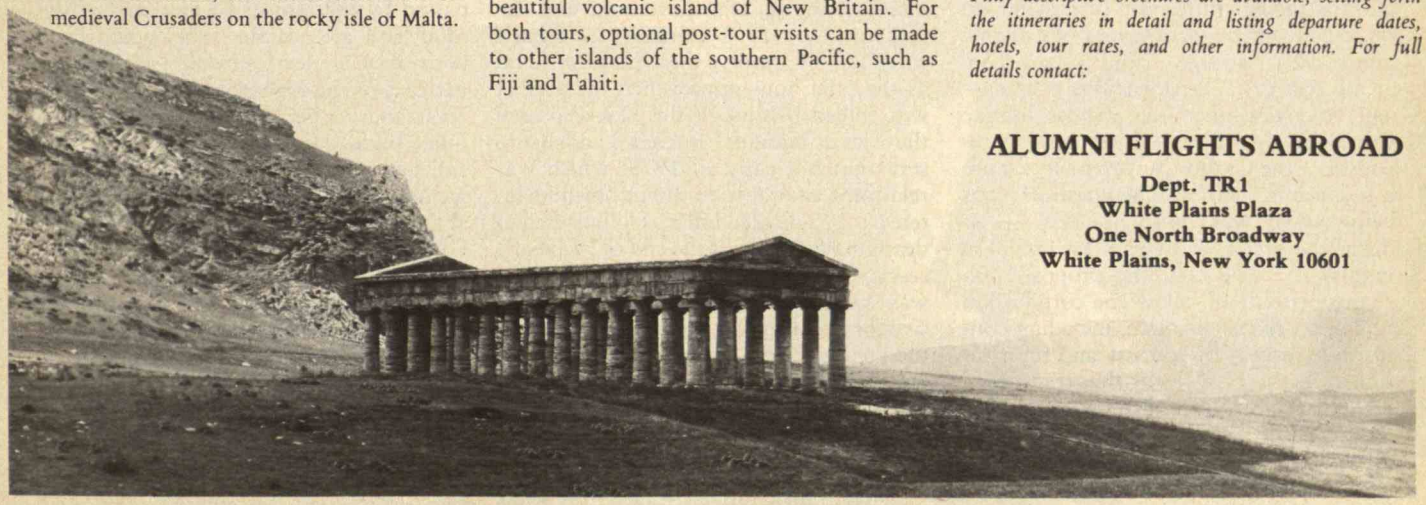

Ian C. T. Nisbet

Alaskan Land: Owners Can't Be Users

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. in Physics is from Cambridge University.*

A few years ago, I was asked for professional advice on an intriguing problem in conservation economics. The Alaska Native Claims Settlement Act of 1971 had allocated 44 million acres of land to the native peoples of Alaska, in partial settlement of their aboriginal land claims. The Act also provided for the establishment of regional native corporations which could select the land within this overall allotment. One of these corporations had chosen land which included an important wildlife habitat harboring a vast seabird colony. Although the bird colony would in theory be protected even if "owned" by the corporation, it would be more secure under federal management, so a proposal had been made to exchange the land in question for a piece of federally-owned land of equivalent value located elsewhere. The problem was to establish "equivalent value." What, I was asked, is the value of 5 million seabirds?

The colony is one of the largest and most spectacular in the world, a biological equivalent of Niagara Falls or the Grand Canyon. Environmental economists usually assign very high value to unique natural assests of this kind, on the principle that their modification or destruction represents an irreversible loss of a highly appreciated resource. If one values them at the cost of replacement this is equivalent to giving them an almost infinite value, since we do not know how to reconstruct the Grand Canyon or to restore a lost seabird colony. The question I was being asked was more practical — to define the exchange value of the land. On inquiry, I found that the proposed exchange would still allow the corporation rights to use the resource, including control over access by tourists and the continued harvest of birds by traditional methods. So I concluded that the main thing that the corporation would be asked to relinquish was a piece of paper — the nominal title to the land. I suggested that the value of this piece of paper was probably quite small, and that the best way to establish its value would be to announce that it was for sale and to solicit bids.

An Unanswered Question

Much of the recent bitter debate over the disposition of Alaskan land has reflected a similar confusion between the formal ownership of land and the right to use it, in particular the use of federally owned lands.

The question of ownership was in fact settled in 1971. The Alaska Native Claims Settlement Act had allotted 104 million acres to the State of Alaska and 44 million acres to the native peoples, retaining 226 million acres in federal ownership. Although this division was a compromise which left no-one fully satisfied, to outside parties it now appears to have been extremely generous to the Alaskans. The allocations of land correspond to about 70 acres per person among the native peoples, 30 acres per person among the non-native residents, and only 1 acre per person among the U.S. population at large. Moreover the state and the native corporations were permitted to select land which included a disproportionate fraction of the mineral, oil, and timber resources of the state.

The principal remaining issue was how the federal lands, 60 per cent of the state, should be used. Some 26 million acres already comprised national parks and national wildlife refuges, and another 20 million acres was marked for national forests, a large part of which was leased for lumbering. The question was how much more should be placed in protected categories — wilderness, national parks and wildlife refuges, wild and scenic rivers — and how much should be opened up for mining, lumber, transportation, and development. In 1971 Congress gave itself seven years to resolve these problems, and as the final hour approached the verdict was stalled. Although the House passed the Alaska National Interest Lands Conservation Bill early in 1978, which was relatively favorable to environmental interests, an amended bill was filibustered to death in the Senate at the end of last year's session. An attempt to extend the deadline was frustrated by one of the Alaskan senators. Thereupon, in December, 1978, the President acted to protect most of the lands covered by the House bill, designating some 107 million acres as National Monuments or similarly protected areas. His action preserves the freeze on development and gives the 96th Congress another chance to resolve the issues.

Anthony Russo

The principal protagonists in the battle for federally-owned Alaska were the developers, who fought to keep the lands open for mining, oil and gas extraction, and lumbering, and the environmentalists, who sought to preserve the "last frontier" from the heedless exploitation that has marred unprotected federal land in the other 49 states. The third party consisted of the representatives of Alaska, who pressed for the state's right to control the use of land within its borders. Apart from their grand scale, the basic issues were thus the same as those in any other dispute over local land-use planning.

Resolving State's Rights

The case of Alaska had some unusual features, however. In the first place, the developers' case was unusually weak. Even under the "conservationist" bill passed by the House, 63 per cent of the total land area of the state would have been open to development, including 95 per cent of the high-potential oil and gas areas and 70 per cent of the lands with other mineral potential. The developers still had ambitions for a few key areas, including the coastal plain of the Arctic Wildlife Range and the Tongass National Forest. But their credibility had been damaged both inside and outside Alaska by the oil industry's misrepresentations of the Alaska pipeline. Even as their lobbyists were arguing that development of Alaska's resources was essential to meet future demands in the United States, much of Alaska's lumber output was being exported to Japan, and the oil industry was working to obtain exemptions to ship

Alaskan oil to Japan also.

The interests of the state were not monolithic, either. A series of close elections has demonstrated a fine balance between proponents and opponents of rapid development. Alaska has developed a vigorous environmental movement of its own, as many people who moved to the state to live on the edge of wilderness have become threatened by its rapid development. Even the proponents want development on their own terms: after the pipeline fiasco they distrust the promises of outside corporations. Thus the main concern of the state representatives was not to achieve permissive regulations for development of federal land, but rather to ensure that the state had some influence over its development, through a proposed system of "co-operative management." This concept was rejected by the Congress, which saw it as a dangerous precedent for federal land in other states.

The interests represented among the native peoples are different again. The 1971 Act not only deprived them vast areas which they had traditionally used, but imposed on them two alien concepts: collective capitalism, and ownership of land. Some native Alaskans see the prospective development of federal lands as a threat to their way of life; others see it as an opportunity for profit and investment. Most general was concern that protection of federal lands would preclude their use of the lands for traditional purposes. However, provisions in the House bill would have allowed subsistence hunting even in wilderness areas, and sport hunting would have been permitted on most federal lands. In any case the concept of hunting by "traditional" methods has become blurred as snowmobiles, motor boats, and rifles have infiltrated that tradition.

The ultimate issue raised by the Alaska debate is the manner in which conflicts between regional and national interests are resolved. The Senate has traditionally deferred on matters that affect only one state to the views of that state's senators. Somehow the Senate accepted the highly questionable assumption that the use of federal land in Alaska is one of these matters that affects only Alaska. Accordingly its senators were able to block passage of a bill that clearly had majority support in both houses. Pro-development interests doubtless considered this action reasonable in fending off federal abrogation of state's rights. They were outraged that the President, who had not carried the state, should then have over-ruled the "will of Congress." Environmentalists, on the other hand, had found it outrageous that the system permitted representatives of a constituency of only 300,000 people, with divided interests, to prevent enactment by the federal government of regulations over the use of its own land. From either viewpoint, the events illustrate the failure of the democratic process to resolve issues that require the balancing of local against national interests, and long-term against short-term benefits. □

Effects of Energy Taxation

John Boshier's article in your September issue, "Can We Save Energy By Taxing It?," brings out some vital features of energy-taxing proposals which had received little previous public discussion. One is the conclusion that "an energy policy which raises the price of energy relative to that of labor will in the long run serve the dual goals of energy conservation and full employment." The beneficial effect of energy taxes on employment has been widely misunderstood and misrepresented.

But them Boshier spoils this promising start by some extraordinary misstatements. For instance: "A general energy (or B.t.u.) tax . . . if applied to oil . . . (would have) little effect in encouraging fuel substitution." But by definition, such a tax would not be applied to coal, wood, wind, solar energy, wave power, and all the other alternatives which under present circumstances the general taxpayer is being asked to subsidize. Of course such a tax on oil would encourage substitution. It would also have a greatly stimulating effect on all alternative technologies.

He falls into the trap (which also caught the Ford Administration) by stating that "this type of (general energy) tax is undesirable in instances where non-energy by-products are involved: because of the use of natural gas in products such as fertilizer, for example, complicated exceptions would probably accompany any general tax." But of course, fertilizers and plastics and carbon black and so forth *are* energy uses. By encouraging their manufacture with under-priced fuels we are in effect subsidizing them, and we are thereby penalizing the use of alternatives, such as animal manures, sewage sludge, and compost on the land, and such as the recycling of old tires to produce carbon black for new tires, and so forth.

His two most damaging misstatements concern the effect of increasing energy prices, through taxation, on inflation and on poor people. He writes that: "rising energy prices mean that general inflation will be hastened." Boshier fails to see the essential difference between the effects of increases in energy prices imposed by the producers, increases which are indeed inflationary, and increases brought about by taxation, which are deflationary. The effects are particularly deflationary if the proceeds of the energy taxes are used to meet the external costs of energy use, including the research and development costs of alternative energy technologies, and perhaps (more controversially) including the hidden defense costs which are an insurance to protect our overseas energy supplies in times of future trouble. Energy prices which are at present effectively subsidized because their use induces huge expenditures on the part of others (even if those "others" are in many cases the same people) are enormously inflationary because the system forms an unstable positive-feedback loop, like a house with a reverse thermostat. Our long-term inflation can be largely blamed on similar subsidized feedback loops throughout the economy.

With regard to the effect of energy taxes on the poor, Boshier makes a damning, and false, indictment: "Because energy-price increases and taxes will be regressive . . ." The concept of feeding back a proportion of energy taxes through the Internal Revenue Service in equal installments to all U.S. adult residents, a concept which the Carter Administration proposed for its Well-Head tax, and one which I believe I had some responsibility for originating, is in fact highly progessive. Richer people devote higher actual expenditures on energy, directly and as a component of all goods and services, than poorer people, yet the poor individual would receive the same energy rebate as the rich. This highly progressive income transfer is entirely justified, both pragmatically and morally, because the poor presently bear many of the external costs, especially the pollution consequences, of energy use (including petroleum use as a raw material).

Boshier does a grave disservice, in his otherwise scholarly article, by adding to the myths which have already done great damage to the national debate over energy-policy alternatives.

David Gordon Wilson
Professor of Mechanical Engineering
M.I.T.

Mr. Boshier responds:

Professor Wilson correctly detected one misstatement: I intended to say "a general energy (or B.t.u.) tax — (would have) little effect in encouraging fuel substitution. If applied to oil, the effect would be to increase the price of all petroleum derived products."

But I went on to say that complicated exceptions probably would occur, not that they should occur, and that these exceptions detract from the value of the tax.

With regard to inflation my statement was intended to point out that a rise in energy prices will, other things being equal, cause price increases for most goods and services (i.e. price inflation). It may be possible to design a taxation and government expenditure scheme that is deflationary, but I don't see how Professor Wilson can argue this is true for all energy taxes themselves.

Finally, as to whether such taxes are progressive or regressive, I believe this is a very complex area which both I and Professor Wilson have oversimplified. Certainly the proposed well-head tax refund is progressive, as would be energy stamps or lifeline rates, but this does not contradict anything in my article. It is part of the welfare overhaul that I suggest would be necessary.

"A Reasoned and Thoughtful Evaluation"

Thomas Najarian's article is a reasoned and thoughtful evaluation of the possible effects of low-level radiation exposure. But there is a most serious omission, a source of radiation exposure that overshadows the small doses Dr. Najarian is considering. The major exposure of the populace at large comes from diagnostic or therapeutic medical techniques. In a typical year over 60 per cent of the U.S. population will have diagnostic x-rays taken. This could easily amount to an exposure of several rems for an individual, an order of magnitude greater than the 0.2 rem given as the annual exposure of the average nuclear worker. Clearly no significant evaluation of the effects of low-level radiation exposure can be made until the medical history of the individual is factored in. If Dr. Najarian is to successfully grapple with this problem he must first look to the record-keeping of his colleagues.

James L. Jones
Cambridge, Mass.

Dr. Najarian responds:

Although it is possible that some Shipyard workers received as much as several rems of medical x-ray exposure in any one year, the average annual whole-body dose from medical diagnostic x-rays in the United States in 1970 was 72 millirems. This is well below the 200 millirems per year of nuclear shipyard workers. The population which receives the most x-ray exposure from this source is on average the severely or chronically ill, and these are not likely to be employed. Despite these facts, I agree that a study of nuclear workers would be more useful if data could be found on their medical x-ray as well as their occupational exposures.

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DAR POMORZA

Sail Power for the World's Cargo Ships

by Lloyd Bergeson

Wind energy could replace a significant part of oil consumed in sea transport. A conversion program, however, requires support from government.

Through the end of the last century, sailing ships carried a significant portion of the world's trans-ocean cargoes. But by the close of World War I, they had been virtually driven from the seas by steam ships that used low-cost fossil fuels for steady power and thereby kept reliably on schedule. The economic advantage of steamers and later diesel motor ships continued without challenge into the present decade. Then, with the Arab oil embargo of 1973, the cost of Arabian light crude oil exploded — from about $2 (U.S.) per barrel to $11.50. Recent forecasts of world energy consumption and costs indicate that the price of marine bunker oil, which is about $15 per barrel as of this writing, may double or triple within the next decade.

Such projections are of enormous concern to operators of the cargo ships now plying the seas: expenditures for fuel make up 20 to 30 per cent of the total cost of operating a modern vessel. And altogether, bunker oil for powering this commercial fleet — which includes approximately 25,000 ships of more than 1,000 deadweight tons — accounts for 5 to 8 per cent of the total oil consumption in the world outside communist areas.

In this context it is possible to identify the benefits of even a partial switch of the world's commercial fleet back to sail power. Sails constitute an elegant and technically feasible solar energy conversion system that remains unexploited by energy planners and industry. Proven in practice over many centuries, sail systems can be developed anew with an expense that is trifling compared to that of many energy systems. Under the standard rules for determining return on investment, sail power — taking advantage of modern technology — would almost certainly prove attractive economically in at least some circumstances, and these should be sought out. Without question, widespread use of this non-polluting and ever-regenerating energy source would benefit the world's environmental and energy balance sheets.

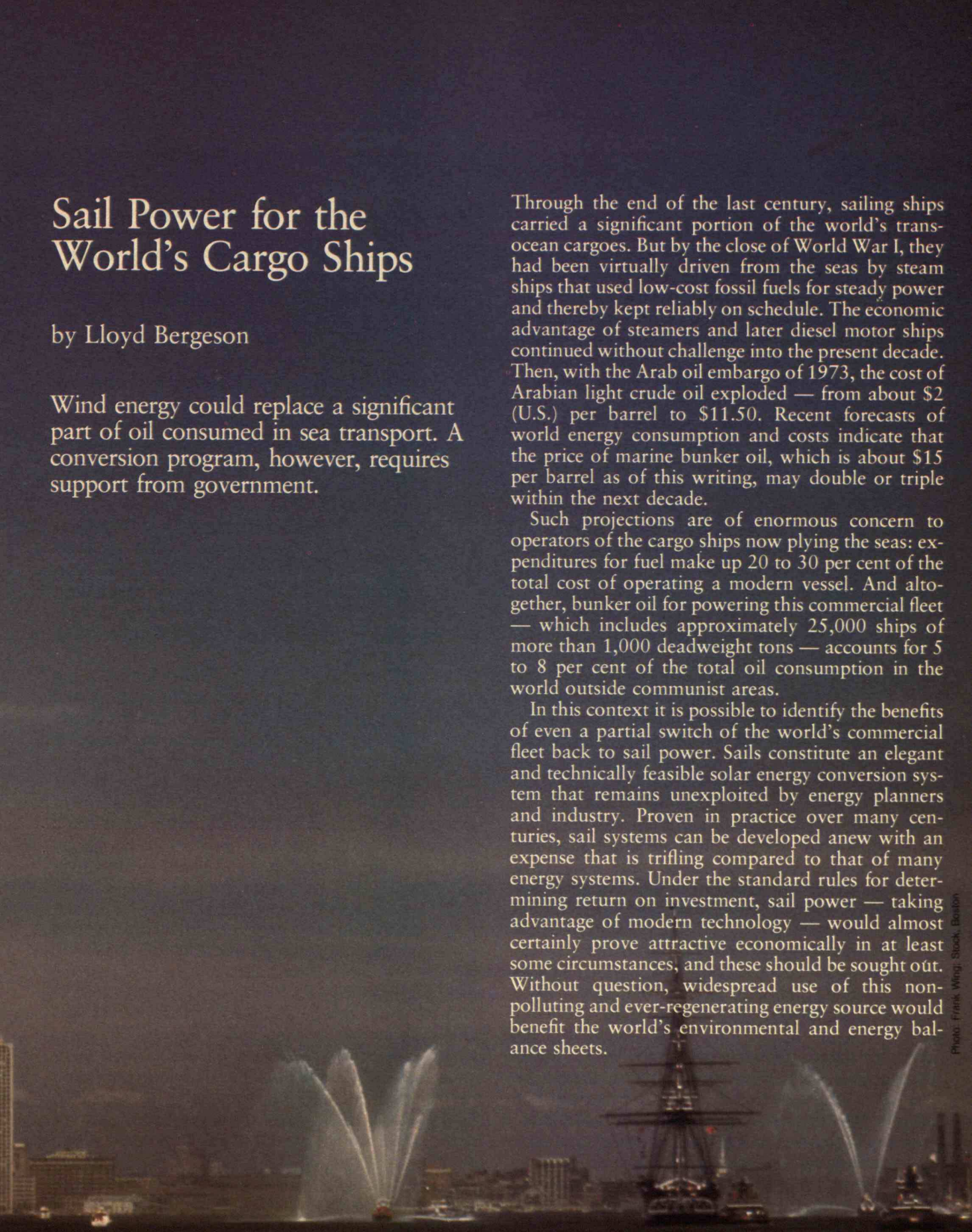


Photo: Frank Wing, Stock, Boston

Oil Consumption and Supply

Total oil consumption in the world outside communist areas is currently on the order of 55 million barrels per day. Of this amount, ocean transportation now takes 4 million barrels per day, or 200 million barrels per year. By the year 2000, according to conservative estimates, world demand will have reached 90 million barrels per day. At that not-so-distant date indicated usage for ocean transportation will be 4.5 to 5.4 million barrels per day — if it can in fact be supplied.

There are, of course, alternative energy sources for ship propulsion: coal, and nuclear power. But we now realize that the use of coal may have to be drastically curtailed because of environmental considerations. And the several "Achilles heels" of nuclear power have been well documented, not the least being our absolute inability to date to solve the formidable problem of safe waste disposal.

Thus, if coal and nuclear systems produce less than their potential, there will be even more pressure to conserve energy and to develop non-polluting, renewable sources. Sail power for ship propulsion is an impeccable candidate on both these scores.

Under the circumstances, it is apparent that even a reduction of 10 to 20 per cent in bunker oil consumption achieved through a programmed switchover to sail power would have global significance: at $15 per barrel, the world's ocean transportation fuel bill could be reduced by as much as $5.5 billion per year.

Indeed, rigorous analysis may well confirm that sail power has the potential ultimately to fulfill 50 per cent — or even 75 per cent, if need be — of all ocean transport requirements. Even in the absence of a crisis, potential savings of between $5.5 billion and $22 billion per year would seem to justify a substantial investment in converting to sail-wind energy.

It seems urgent, therefore, that we reappraise the potential of sail power for commercial ships and develop an authoritative and practical program that would be meaningful to maritime entrepreneurs, investors, and planners in the areas of energy and economic development. The appraisal should bear in mind not only the state of the art as represented in the last commercial sailing ships but also the valuable lessons that have been learned in the intervening years.

The Last Great Ships: Advanced Designs

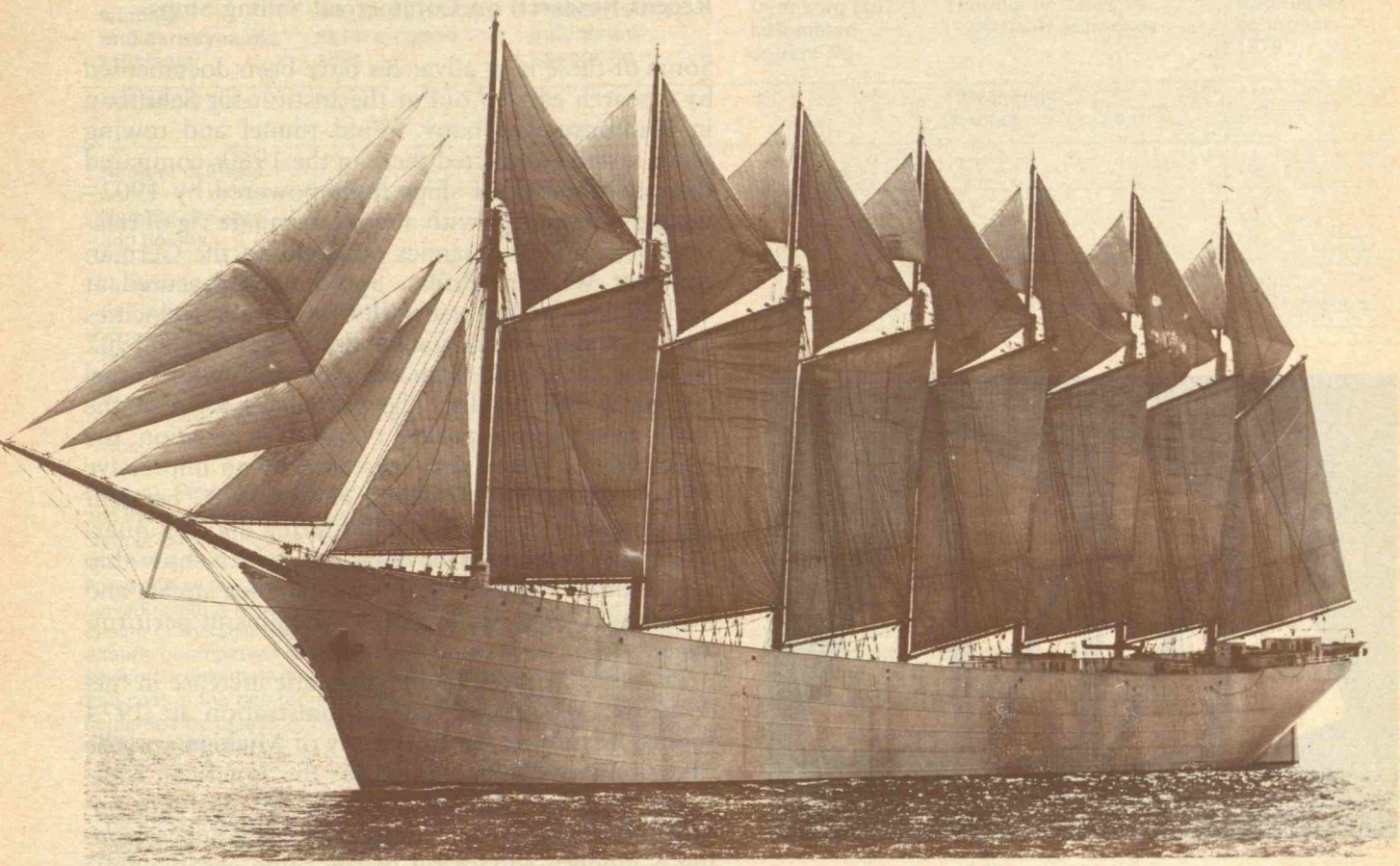
On both sides of the Atlantic the designers, builders and operators of the commercial sailing ships of the early 1900s brought the vessels to a high state of development. The designers took full advantage of the strength of steel for hulls and spars and incorporated labor-saving devices and auxiliary power for handling sails, anchors, cargo, steering, and mooring warps.

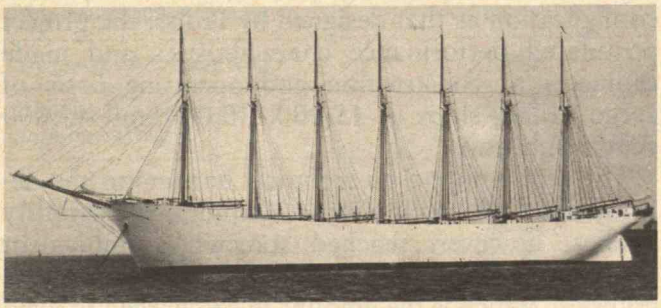
The square rig reached its peak with the development of the German full-rigged ship, the *Preussen,* of the German Laeisz line. Built in 1902, it carried 8,000 long tons of cargo while displacing 11,150 tons of sea water. The vessel's sail area of 60,000 square feet — nearly one and a half acres — was divided among 53 sails on five masts. Despite the huge area, all these sails and the square yards were handled safely by a remarkably small crew of 41 deck hands using a hand-powered winch system. Simple division shows that each man could handle 1,463 square feet of sail.

The ship was relatively full-bodied for a sailing ship: in the terminology of naval architecture, it had a relatively high block coefficient of .669; this figure, which is one indicator of a ship's performance, is derived from the actual displacement in cubic feet divided by the product of the water line length, the beam, and the loaded draft. Speed of a displacement vessel is a function of length, and the *Preussen* had a maximum "theoretical" hull speed of 22 knots; superbly managed and sailed, the vessel proved over the years to have a maximum sustained sea speed of 17 knots and an average voyage speed of 7.5 knots.

The low average voyage speed of the *Preussen* was in part attributable to the vagaries of wind and weather but, more importantly, to the fact that the steel hulls of the 1900s fouled rapidly because their bottoms could not be sheathed with copper as was done with earlier wooden-hulled vessels. The component of frictional resistance due to fouling is highest at low speeds: for example, U.S. Navy data on the resistance of steel warship hulls in the 1890s showed that a vessel under the same thrust — either motor or sail — that produced a 7-knot speed with a clean bottom was slowed by 2.8 knots, or 40 per cent, when fouled. The same vessel doing 11 knots with a clean bottom was slowed by only 1.1 knots, or 10 per cent, when fouled.

In New England, multi-masted ocean-going ships were also operating successfully around the turn of

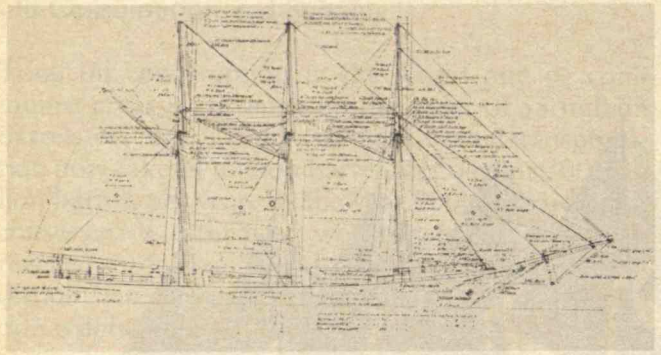


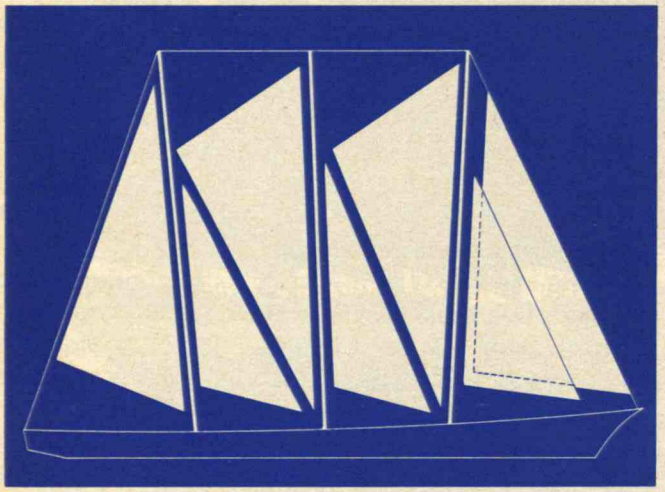


The seven-masted schooner *Thomas W. Lawson (top)* built in Quincy, Mass., in 1902 carried 8,000 to 11,000 deadweight tons and represented the ultimate design in the development of the Yankee fore-and-aft rigged commercial schooner. Its immense working sails — some 40,000 square feet in area — could be hoisted and reefed by only 12 men aided by steam-driven winches. The ship's sail plan pointed the way to the configuration of rig and sail that may be best suited for modern commercial ships. Designed for the coastal coal trade, the vessel was serving as an oil tanker when —in a kind of ironic prophecy of events to come — it was wrecked in the Isles of Scilly southwest of Land's End in England. In these pictures she is shown in "light" condition — without cargo. (Photos by N. L. Stebbins, 1902, from the Society for Preservation of New England Antiquities.)

the century — but these vessels were designed with fore and aft schooner rigs. The peak of this development was reached also in 1902 when the seven-masted ship, the *Thomas W. Lawson,* of some 8,000 deadweight tons, was launched at the Fore River Shipyard, in Quincy, Mass. The ship's 40,620 square feet of sail were divided among 18 sails handled by only 12 deck hands. Our arithmetic here gives 3,385 square feet of sail per man. The Lawson also had a high block coefficient (.71) but handled like a yacht even when fully loaded, according to her designer, B. B. Crowninshield. The Lawson's theoretical hull speed nearly equalled that of the *Preussen.*

Since the days of those great ships, naval architecture has drawn on advances in many diverse technologies. Petrochemical derivatives, for example, have made possible large sails of almost ideal fabrics with less than 2 per cent stretch and strength approaching that of steel. Further, these sails are virtually mildew-proof and retain their properties for years, minimizing the enormous maintenance





A schooner of yesteryear and a modern rig for it. The three-masted steel cargo schooner *Mexico* (top) was designed by the naval architect B. B. Crowninshield and built in Norway in 1904 for trade in the Gulf of Mexico. (Crowninshield was also the designer of the *Thomas W. Lawson*.) The *Mexico* was built to carry 600 deadweight tons on a draught of nine feet. Because of this shallow draft, the vessel was fitted with a centerboard to enhance sailing to windward. This was the first time a centerboard was used in a steel mercantile vessel of any size and presaged one feature in the design of modern cargo sailing ships. Below is a modern three-masted staysail schooner rig as applied to the original hull of the *Mexico*. (Drawing: Frank MacClear)

and sail replacement programs (which added to crew size) of the early square riggers.

The great advantages of modern sail material, coupled with spin-off knowledge from modern aerodynamics research and development, have brought major advances in sails and rigs. (In the early 1900s, naval architects were inhibited by even the best materials, flax and cotton, in obtaining desired airfoil shapes, which they arrived at by intuition, empirical data, or theory, unverified by wind tunnel testing or other experimental work.)

Recent Research on Commercial Sailing Ships

Some of these new advances have been documented by research carried out at the Institut für Schiffbau in Hamburg, Germany. Wind tunnel and towing tanks tested conducted there in the 1960s compared the performance of ships hulls powered by 1902–vintage square rigs with a modern square rig of relatively clean aerodynamics designed by the German engineer Wilhelm Prölss. Speed was measured at various angles of course with varying wind velocities and sea states, and actual log book data for the 1902 rig were correlated with the tank and wind tunnel test data. The results: The propulsive force of the 1902 vessel was improved twofold; in addition, the mean voyage speed was increased by an impressive 58 per cent under sail alone, and up to 82 per cent using modest auxiliary power during about a quarter of voyage time. Polar diagrams, which show ship speed under varying wind velocities, sea states, and headings, clearly summarized the gains in performance.

Probably inspired by the dramatic increase in fuel cost, the U.S. Maritime Administration in 1974 funded a study at the University of Michigan on the "Feasibility of Sailing Ships for the American Merchant Marine." Taking advantage of the information obtained in the Hamburg research and assuming a modern square rig of the same aerodynamic configuration as that designed by Prölss, the project postulated performance characteristics and made estimates of construction and operating costs of cargo sailing ships of 15,000, 30,000 and 45,000 deadweight tons.

The report found no technical barriers to the development of such ships. Economic feasibility studies, however, reached somewhat ambivalent conclusions. Using the Required Freight Rate (RFR) criterion, which is the amount to be charged to yield a specific return on investment, these studies compared the performance of the sailing vessels on several trade routes with that of steamers of equivalent size. At $11.25 per barrel for fuel cost, the sailing ships were found to be marginally uneconomical. Regrettably, the study dismissed the use of "motor sailing" — that is, using both sail and auxiliary power — as having been proved impractical in the early 1900s.

Many believe, however, that a study in greater depth would show substantial savings for sail power even on the basis of standard economic analysis.

It is also believed that a so-called Net Energy

Factors affecting windage and aerodynamic efficiency	Preussen (1902) square-rigged ship	Prolss (1960's) automated square rig	Dynaship (1977) automated square rig	Thomas W. Lawson (1902) gaff-schooner	Boomless schooner 1979
Number of Sails	53	25	30	19 working 25 total	11
Number of Masts	5	5	6	7	5
Number of Yards and booms	42	30	36	16	0
Number of shrouds and stays	almost infinite	0	0	less than ½ of square rig	about ½ of Lawson's
Windage	100	60	60	60	40
Weight	100	100	100	60	50
Cost	100	140	140	80	80

(Above). Features of square-rigged and fore-and-aft rigged ships and the relative windage, weight, and cost of the different rigs. The components of the rigs, both past and proposed, are compared insofar as they affect windage and aerodynamic efficiency. The figures show that the gaff-rigged schooner of 1902, the *Thomas W. Lawson,* had a far simpler and "cleaner" rig than even the Prölss design or the Dynaship. The boomless schooner rig, which has already been proven at sea, is dramatically better than that of the *Lawson.* While the values assigned to the relative windage, weight, and cost of the rigs represent the author's judgment and must be confirmed by research, the boomless schooner appears to offer exciting potential.

Tacking angles for maximum speed to windward	Angle to true wind (degrees)
Preussen 1902 square rig	70
Dynaship 1977 square rig	55-60
Thomas W. Lawson 1902 fore-and-aft rig	55-60
Boomless 1979 fore-and-aft rig	
Sail alone	40-50
Motor sailing	20-40

(Below). The relative tacking angles and minimum angles to the true wind that are practical for different ships and rigs when close-hauled to achieve maximum speed. The ability to sail efficiently close to the wind is desirable on several important trade routes, notably in the crossing of the North Atlantic between North America and northern Europe. The square riggers of the past lacked this windward capability and were forced to follow a much longer and more southerly east-to-west route than would a modern ship. The relative advantage of the modern fore-and-aft rig is apparent, particularly in its potential in "motor sailing."

Analysis (NEA), if one were performed, would show sail power to be much more economical than a fossil fuel power plant under selected conditions. This tentative conclusion is based on results of rough calculations made in 1976: over a 25-year period, they showed, the average cost per year of a sail power system — including original investment — is but 15 per cent of the cost of a ship power plant fired by fossil fuel. ("Cost" here refers to the amount of energy required.)

While a number of subsequent papers have both advanced and challenged the case for commercial sailing ships, no further significant research has been conducted. (It should be noted, however, that considerable work has been done on the speed and performance of sailing yachts, including the gathering of useful data at sea.)

Nevertheless, we now have evidence that square rigs, designed with new materials and scientific knowledge and applied even to the well-developed hull forms of 80 years ago, would show significant improvements in performance. Given the full scope of advances in present-day marine engineering, however, we are confident that we can design com-

mercial sailing ships superior in many respects.

Against this background, I joined forces with fellow naval architects Frank MacLear, who has designed many successful ocean cruising yachts, and Professor Henry S. Marcus, of the M.I.T. Department of Ocean Engineering, who is an authority on ocean transportation. Together we have developed a specific program to evaluate the feasibility and confirm the advantages of changing a significant proportion of the world's shipping to sail. We feel that such a basic study can best be supported by government and have so proposed to the U.S. Maritime Administration (MARAD) and to the federal Department of Energy (D.O.E.). In addition, however, we are actively soliciting funds from environmentally oriented foundations and industry.

A Program for Conversion to Sail Power

In devising a program that would demonstrate the economics and practicality of sail propulsion at least cost and in minimum time, we felt intuitively that ships of about 600 to 1,000 deadweight tons were most suitable for the initial stage of development and testing: such vessels would be about one tenth the size of the largest commercial sailing ships of the past, but they could be designed, built, and tested at lower cost and in considerably shorter time than larger vessels. We also recognized the task would entail an operational learning curve: there are few persons now alive who have ever commanded or served aboard large commercial sailing ships, and the art of managing them safely will have to be, in part, relearned.

Our study will, of course, cover a series of ship sizes, including vessels of 48,000 deadweight tons. But while super sailing ships of, say, 200,000 deadweight tons are conceivable, it's worth noting that the largest sailing ships of the past were of 8,000 deadweight tons, and one should be aware that super-size ships may incur unpredicted problems of scale.

To reach our ultimate development objective of full-scale operation and evaluation of 8,000-deadweight-ton ships, our program is divided into three phases:

☐ Analysis of ship characteristics, trade routes, and commodities to determine routes best suited for sailing ships of various sizes, and to confirm — through a trans-ocean cost analysis — the overall economic potential of sailing ships in world trade.

☐ Detailed design, construction, and trial runs of two or more prototypes of different characteristics.

☐ Marketing and operational studies for full-scale trans-ocean service; development and design and construction of prototypes; evaluation of operations and economics.

The first phase includes studies of potential routes where smaller sailing ships of 800 to 2000 deadweight tons would be most competitive, perhaps in the Caribbean where their economics could be fully tested in actual "market operation," and with suitable commodities. Based on these findings, we would then develop the parameters for ship design, rig, cargo handling and stowage.

Vessel Parameters and Characteristics

We know that modern antifouling bottom coatings can improve the performance of a present-day sailing ship over that of a steel hull of 1902. In addition, we know that ships themselves can be modified in a number of ways to improve sailing performance over that demonstrated in the Hamburg research. These modifications and their advantages include:

☐ Use of a modern fore-and-aft rig, with its greater aerodynamic efficiency and considerably reduced windage (*see page 27*).

☐ Provision of power adequate for "motor sailing" in calms, or near-calms, which is made possible by the fore-and-aft rig.

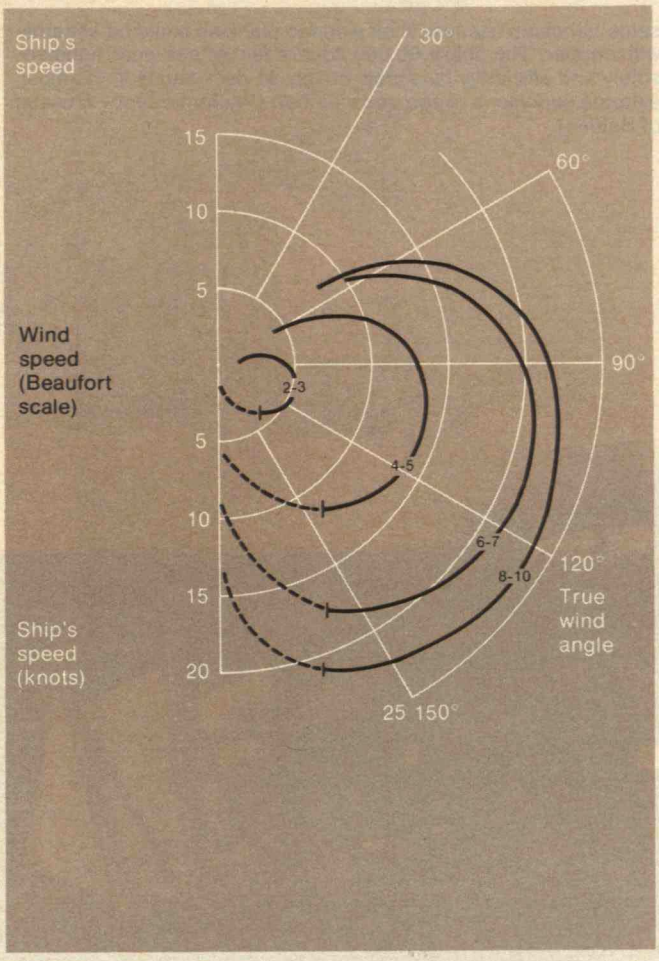
☐ Lower costs of rig, rigging, handling gear, crew and lower operating expenses through use of simpler and safer boomless fore-and-aft rig (*see page 27*).

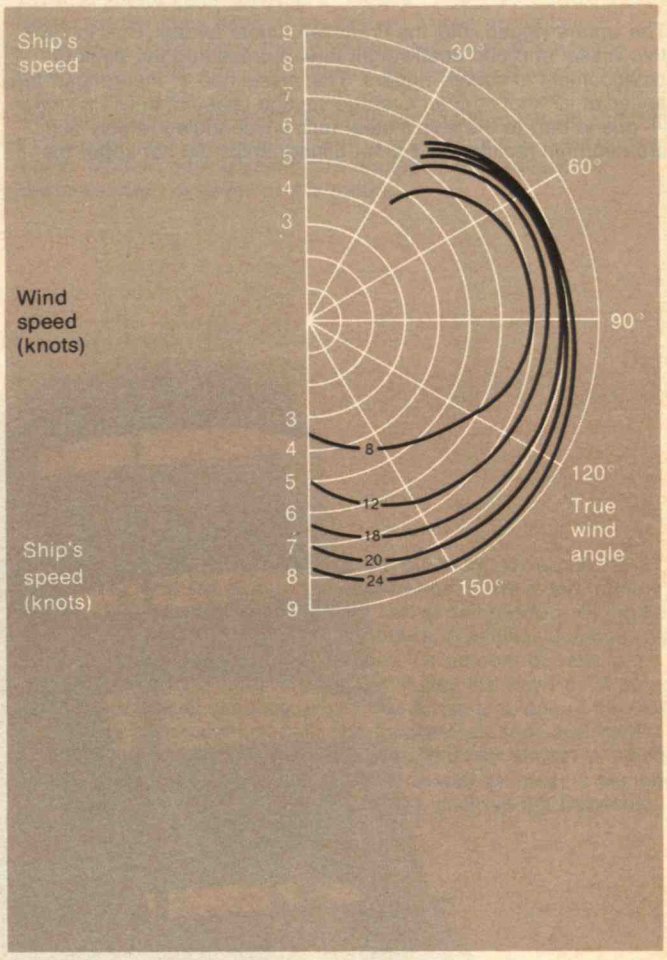
☐ Better performance from hull forms, selected from the "best of the past," that are slightly finer in line than those postulated in the Michigan study.

☐ Use of catamaran hulls on routes that would make best use of their unique characteristics: relatively high speeds, lesser draft, and capability for beaching.

One of the major purposes of our program is to evaluate the relative merits of vessels with single and multiple hulls: single hulls reached a high state of development in the past age of sail, and multiple-hull designs have been used for centuries in the Pacific Ocean and more recently have proved successful in ocean-going sailing yachts.

One possibility for a prototype single-hull design is likely to develop as a relatively beamy, shallow-draft craft of about 180 feet in overall length. It can probably be rigged best as a three-masted schooner.

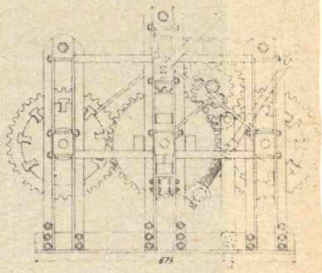


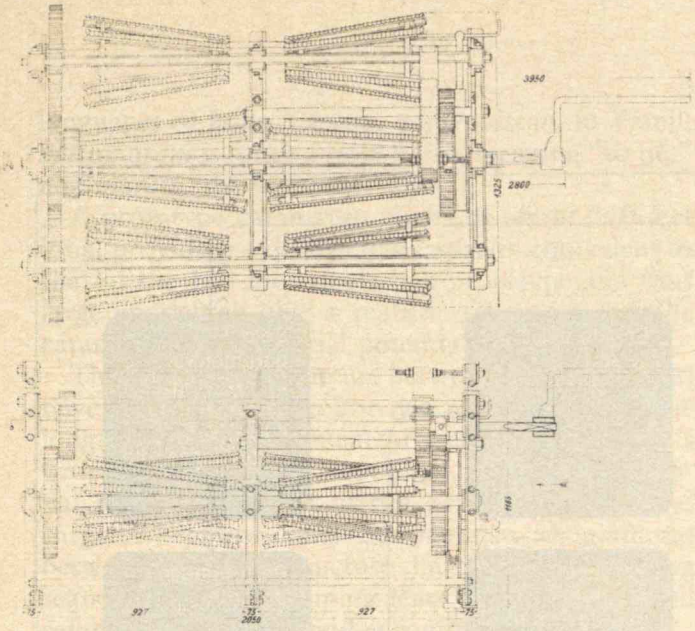


Passage Time of Sailing Ships

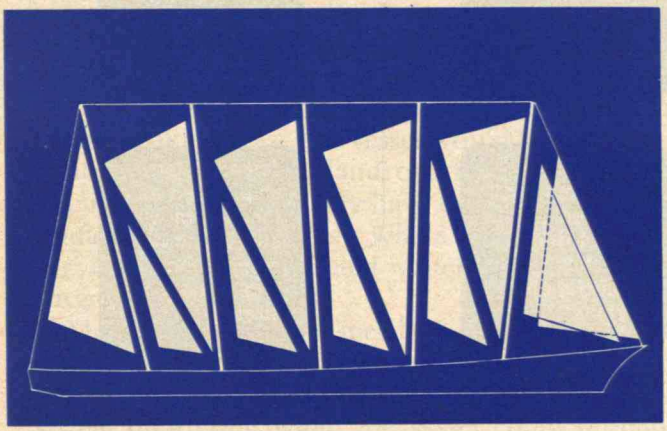
The speed of sailing ships cannot be compared directly with that of ships powered by fossil fuels. In the latter, speed is a function of the power applied through one or more propellers. A sailing ship, however, has a speed potential that is a function of wind strength and direction relative to the ship's heading. For a given voyage, a sailing ship will have an average speed according to its log and an "effective voyage speed" which one can define as the minimum safe distance traveled divided by the transit time. Speeds attainable under different combinations of wind force and relative direction can be represented by what are termed ship performance diagrams, or "speed polar diagrams." Two such diagrams here are for the modern square rigger designed by Wilhelm Prölss (*left*) and for a modern sailing yacht (*right*). The black lines represent the ship's speed at constant wind velocity as the wind swings from dead ahead (zero degrees) to dead aft (180 degrees). The diagram at left shows the ship's speed in knots and wind speed on the Beaufort scale. The latter is a system of code numbers from 0 to 12 classifying wind speeds into groups from 0 to 1 miles per hour (Beaufort 0) to those over 75 miles per hour (Beaufort 12). The diagram at right shows ship speed and wind velocity in knots. The diagrams' radial lines represent the wind's angle from the ship's bow, and the radial scale (circular lines) gives the ship's speed in knots. A modern fore-and-aft rigged schooner will show performance characteristics somewhere between those of the Prölss vessel and the sailing yacht. Given a speed diagram for a given ship, the passage times between any pair of ports can be calculated by simulation in several different ways, including analysis of historical weather data and the use of dynamic weather routing that takes advantage of satellite and other data. Use of dynamic weather routing holds promise of increasing average and "effective" voyage speed of sailing ships.

The square-rigged ship, the *Preussen,* under full sail. Built in 1902, this vessel of 8,000 deadweight tons represented the peak of development of square-riggers. The vessel had a "theoretical" top speed of 22 knots but an average voyage speed of only 7.5 knots — due in part to the ship's steel hull, which fouled rapidly and created high resistance. Earlier clipper ships did not suffer the same handicap because their wooden planking could be sheathed with copper. The ship's 60,000 square feet of sail were handled safely and efficiently by a crew of only 41 deck hands in the most extreme conditions of sea and weather. (Photo: Peabody Museum of Salem.)

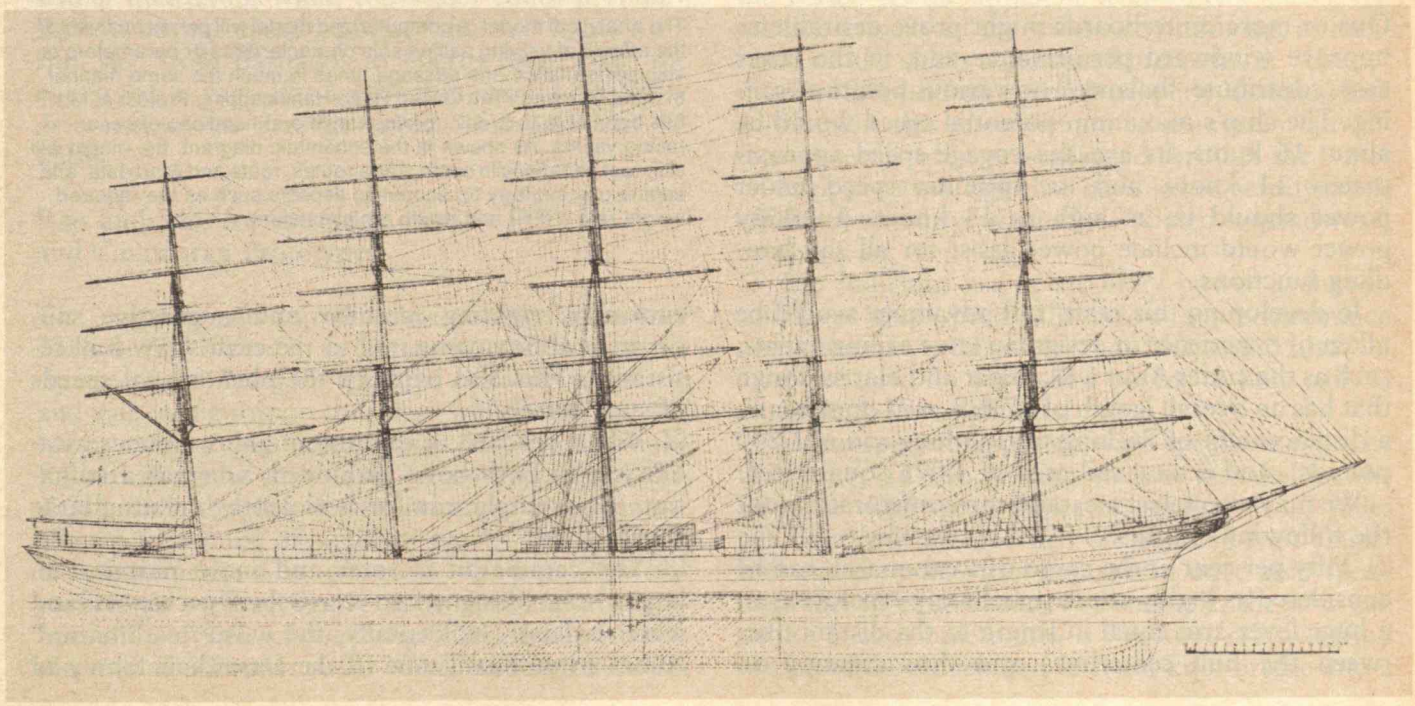


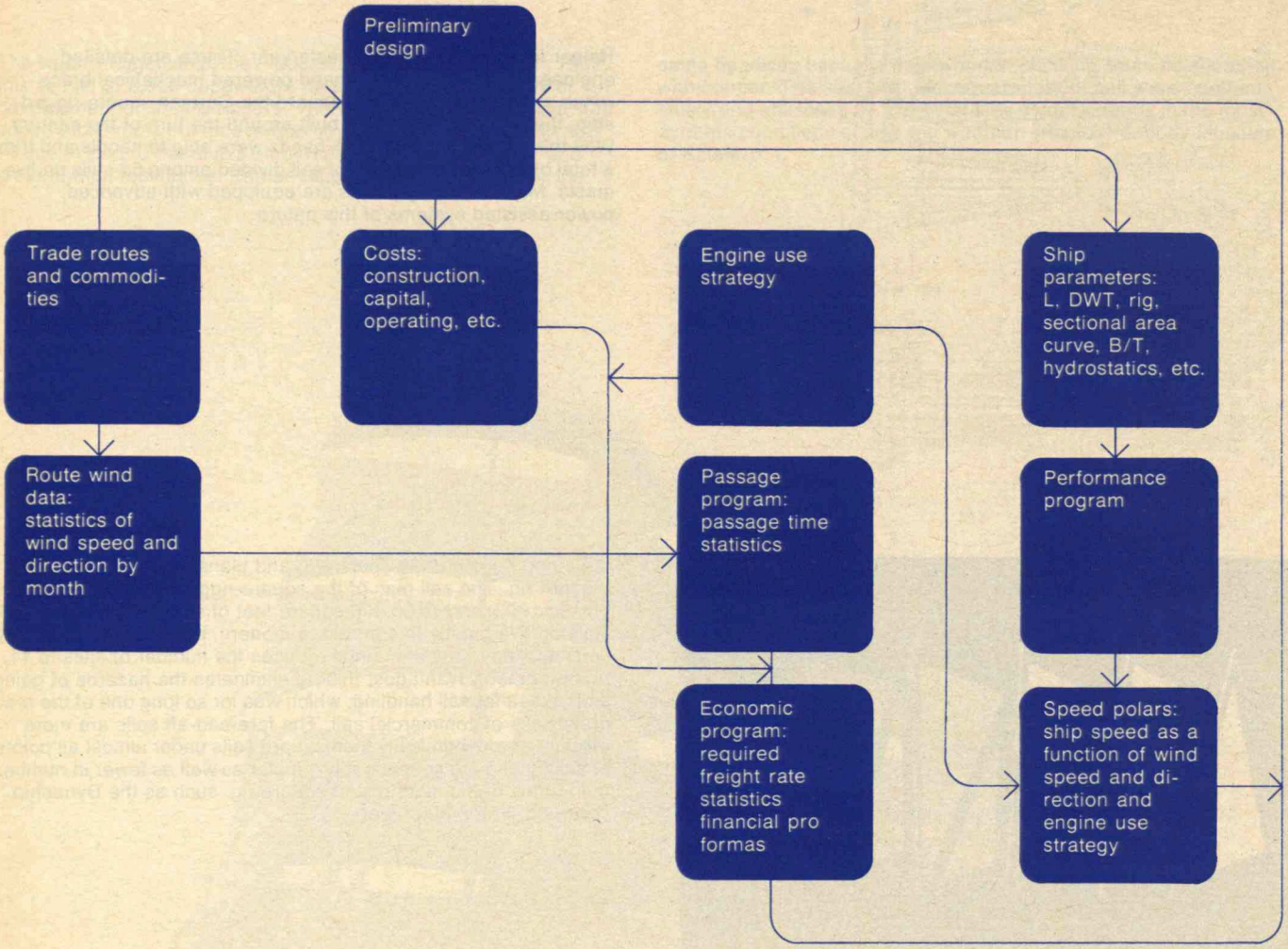


Helper for the deck hand of yesteryear. These are detailed engineering drawings of the hand-powered mechanical brace winch system that was used aboard the German square-rigged ship, the *Preussen,* that was built around the turn of the century. With this system, only 41 deck hands were able to handle and trim a total of 60,000 square feet of sail divided among 53 sails on five masts. Modern sailing yachts are equipped with advanced, power-assisted systems of this nature.



Sails and rigging of 80 years ago and plans for conversion to a modern rig. The sail plan of the square-rigged *Preussen,* (*below*) built in 1902, shows 60,000 square feet of sail divided among 53 sails on five masts. In contrast, a modern, boomless schooner rig (*left*) applied to the same hull reduces the number of sails to 11. Among other advantages, this rig eliminates the hazards of going aloft at sea for sail handling, which was for so long one of the real drawbacks of commercial sail. The fore-and-aft sails are more efficient aerodynamically than square sails under almost all points of sailing and are considerably simpler as well as fewer in number than those of the modernized square rig, such as the Dynaship. (Drawing: Frank MacClear)





The analytical model. A computerized model will permit analysis of the effects of varying sailing ship characteristics or parameters on ship performance and passage times in much the same manner that the H. Irving Pratt Ocean Race Handicapping Project at M.I.T. has been able to predict performance and handicap of ocean racing yachts. As shown in the schematic diagram, the model will also test variations in costs, trade routes, route and wind data, and engine use strategy on economic aspects such as the required freight rate (RFR) and return on investment.

One or more centerboards might prove desirable to improve windward performance and, in the latter case, contribute "balance" on various points of sailing. The ship's maximum potential speed would be about 16 knots, its average voyage speed approximately 11 knots, and its optimum speed under power should be as high as 13 knots. Auxiliary power would include power-assist for all sail handling functions.

In developing this craft, full advantage would be taken of experience in designing large sailing yachts, such as the cutter *Aria,* a MacLear and Harris design that has an overall length of 87 feet, a 21-foot beam, a displacement of 76 long tons (a long ton is 2,240 pounds), and a total sail area of 4,076 square feet.

We may also select a catamaran configuration, for the following reasons:

☐ Fifty per cent of the cargo of a catamaran can be considered as highly effective ballast — operating on a huge lever arm equal in length to the distance between the hull centerlines and thus creating an enormous righting moment and impressive sail-carrying ability compared to the craft's low hull resistance. This also explains the phenomenal speeds of such vessels.

☐ When beached, a catamaran gains immense stability with both bows grounded, whereas a trimaran, for example, can lurch violently, creating large shock loads.

☐ The catamaran is safer and more practical in larger sizes designed to carry heavy cargoes and water ballast. (Incidentally, the word "catamaran" comes from Tamil, one of the Dravidian family of

languages of India, Ceylon, and Pakistan. In Tamil, *kattumaram* is formed from *kattu,* meaning "to tie," and *maram,* the word for "tree.")

A prototype catamaran might be about 220 feet long, providing a deadweight capacity equivalent to that of the 180-foot single-hull prototype and thus large enough to give a realistic perspective of the catamaran's commercial potential.

The connecting structure between the hulls would have no superstructure for two reasons: so that the longitudinal area moment of inertia of the vessel's water plane would be kept large, and the longitudinal mass moment of inertia of the structure and cargo be kept low. Small catamarans with minimum between-the-hulls structure have shown amazing seaworthiness, performing feats that no single-hull sail or power boat could accomplish.

Such a catamaran, therefore, might have a connecting pipe structure with minimum windage and resistance to breaking waves, and decking between the hulls would be open-mesh expanded metal to drain breaking seas. The vessel would be conned, or controlled, from an island on the starboard hull. Each hull would probably have two centerboards in tandem, and the craft as a whole would be designed for beaching in protected waters for transfer of cargo via a bow ramp.

Maximum potential speed of such a catamaran with a light load is calculated to be 25 knots in winds of 25 to 30 knots. Loaded and sailing in a strong quartering wind, the vessel could probably show a voyage speed of better than 20 knots on a run, say, from Barbados to Puerto Rico. Over the course of a year, the catamaran would probably demonstrate an average speed of more than 12 knots.

Rigs and Sails for the Single Hull and Catamaran Prototypes

The impressively small crew of the schooner *Thomas W. Lawson,* in comparison to that of the square-rigged *Preussen,* pointed the way to the rig and sail configuration that may well prove best for large, modern commercial ships. If we are to take full advantage of up-to-date technology in sail material, sail shaping for maximum aerodynamic efficiency, and use of auxiliary power, this direction is confirmed: The obvious answer is what yachtsman will recognize as a fore-and-aft "jib-headed" staysail schooner rig. The rig is not new: the staysail schooner yacht *Nina,* launched in 1928, was successful over four decades of ocean racing.

Both of our prototype vessels — the single hull and the catamaran — would have a three-masted schooner rig with fixed, stayed masts of about the same length. For modern technical reasons and for simplicity, economy, and safety, our plans for the initial prototype rigs call for boomless fore-and-aft sails which would be triangular and fully supported along the full length of the luff, the forward edge of the sail. All sails would be furled or unfurled by a power-assisted roller along the luff, and encumbrances such as moving spars, booms, staysail clubs, gaffs, yard arms, or spinnaker poles would be eliminated.

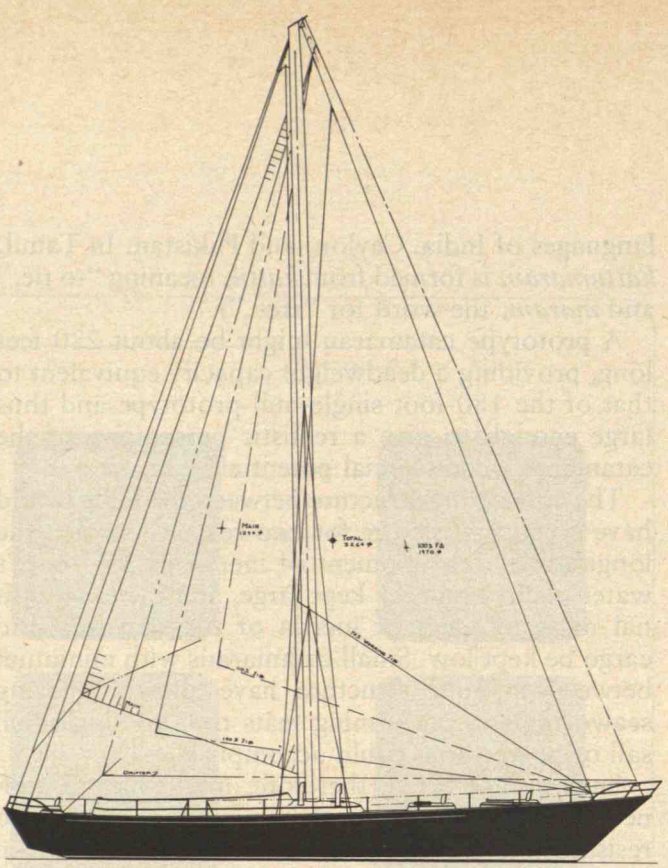
Such sails and the basic procedures for handling them have been tested at sea over about 15 boat-years of experience on vessels designed by Mr. MacLear, including the 62-foot cruising cutter, the *Falcon II,* with about 6,000 miles of sailing, and the 87-foot cutter *Aria,* which has logged some five sailing seasons.

The characteristics of these sails make them ideal for modern commercial sailing ships of relatively large size and with long waterlines when we consider the following points:

☐ Assume a vessel that is initially reaching with the wind abeam: as ship speed builds up, the apparent wind draws ahead. By "apparent" or "relative" wind we mean the relative direction from which the wind appears to blow with reference to the track of the vessel. As the apparent wind draws ahead, the relative velocity of the wind also builds up, as measured on the ship's wind speed indicator. A "clean," modern fore-and-aft rig on a properly designed hull can exploit this phenomenon to maximum advantage in terms of increased speed through the water — as opposed to rigs that have lesser aerodynamic efficiency and drive when close-hauled to windward, or nearly so.

☐ The judicious use of auxiliary power in motor-sailing as ship speed falls below a predetermined minimum can preserve this advantage and also obviate the need for yards and booms to hold sails at an angle in very light airs.

With respect to apparent wind speed we estimate that, in a 12-knot breeze that is initially on the beam, a wind-speed indicator reading of 20 miles per hour will be recorded on our 180-foot single-hull vessel or 220-foot catamaran once ship speed has reached equilibrium. For example, the *Aria* can turn a 5-knot breeze into a 9½-knot relative wind force and the *Falcon* can turn a 6-knot breeze into a



(*Left*). The sail plan of the 87-foot ocean-cruising cutter *Aria* as designed by Frank MacLear for sailing with minimum crew. This rig illustrates modern sail-handling capabilities: boomless, triangular sails that can be furled or unfurled by a power-assisted roller along the leading edge of the sail make it possible to go from zero sail to the maximum 4,000 square feet — or the reverse — in just 40 seconds with a crew of three persons. One person can do the same task in two minutes.

(*Right*). A bulk cargo sailing ship of 45,000 deadweight tons as hypothesized in the 1975 study funded by the U.S. Maritime Administration (MARAD) at the University of Michigan. Tripod masts were specified for the ship, as opposed to the rotating masts proposed by the German engineer Wilhelm Prölss and incorporated in the Dynaship design of the 1960s. (Rotating masts were intended as an aid in setting sails at the desired angle.) With the tripod masts, sail trimming is accomplished by mechanically "bracing" the yards about a pivot on the leading side of the mast. Sails are furled or unfurled by a rotating vertical rod (jack stay) set between the yards and forward of the mast.

9-knot wind speed indicator reading.

The sail area of the catamaran can be 20 to 40 per cent greater than that of the single-hull ship because the catamaran will have approximately three to four times the initial stability of the single hull. Moreover, the added length of the catamaran will permit more sail, to which the ship will respond better because catamarans by nature resist heeling and instead shoot forward in gusts.

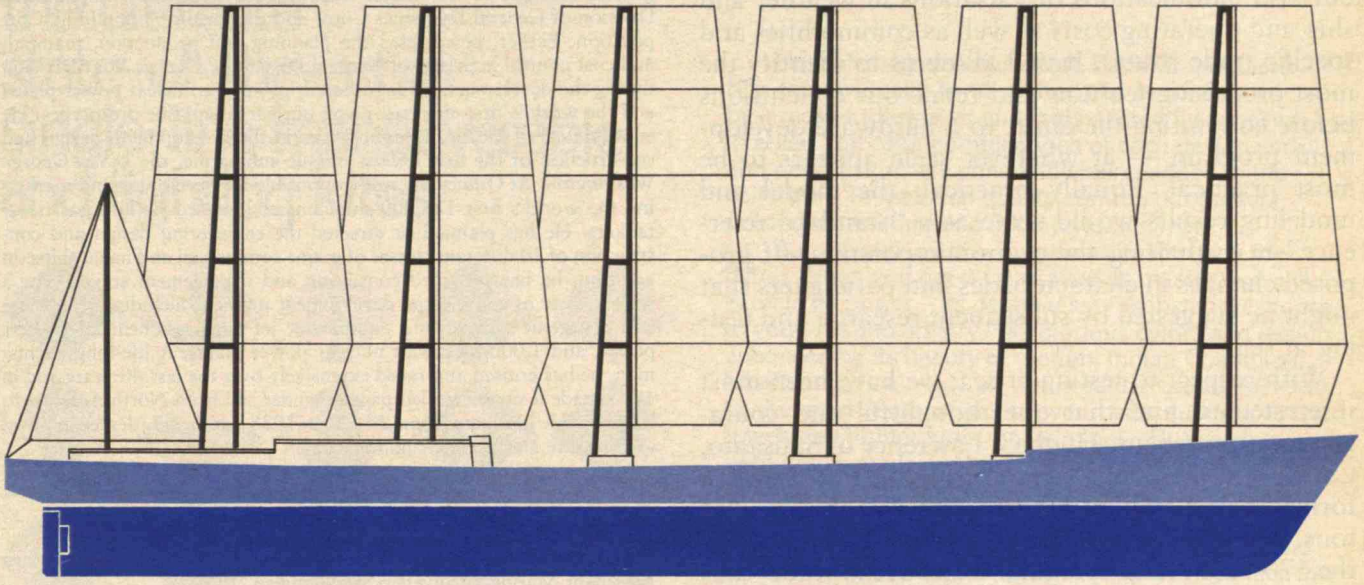
With this rigging and auxiliary assist mechanism, both vessels should be able to get under full sail — with the entire crew on deck — in less than four minutes, according to our estimates; reversing from full sail to complete furl should take a like period. If this seems an extraordinary feat, we should note that the *Aria* can accomplish this with two men on deck in less than two minutes, and the *Falcon* can carry out the same operation — with one man on deck — in less than one minute.

Auxiliary Power and Fuel Tankage

The square-rigged *Preussen* had no auxiliary propulsive power, for a very good reason that has been given succinctly by Captain Alan Villiers: "A real square-rigged ship had too great a windage in her masts and yards and in the tremendous array of wire and cordage to be pushed easily against a head wind." This observation had already been proven in the early 1900s by the Laeisz line's arch competitor, the German Rickmers line, which provided auxiliary power in its large five-masted square-rigged barques but with notable lack of success.

Having eliminated the square rig's enormous handicap to motor propulsion, we can then adopt auxiliary power. The question is: How much? The answer involves trade-offs among cost and required tankage, maximum power required for emergency operation such as clawing off a lee shore in a hurricane, and the percentage of time a ship can be expected to operate under auxiliary power on an average voyage.

A starting "target" for the preliminary design of our ships could be an auxiliary propulsion system producing about 75 per cent of the power normally used in a motor cargo craft of comparable size. Although this prime mover may seem large, it is important to note that such a sailing ship's fuel capacity would be about one-half that of a motor vessel and the actual fuel carried would amount to about 25 per cent of what a fully powered freighter would need. Of course, the amount of fuel carried by a sailing ship would depend on a particular trade route and the season's wind conditions. We anticipate that a sail craft could operate 90 per cent of the time with tanks only half full. Most important, however, is that the annual fuel consumption is projected to be less than 10 per cent of that of a vessel powered ex-



clusively by fossil fuels.

Such generous power would be available not only for emergency use but would also help the craft avoid severe storms by increasing speeds under power and in motor-sailing; in addition, it would permit motor-sailing more closely into the wind. A vessel so powered thus would be able to make fast passages with much greater reliability and safety.

Manning the Future Sailing Ships

It is reasonable to project that the new class of commercial ships can be operated safely with crews significantly smaller than those of even the best of the last square riggers. The large American schooners of the 1900s, as we have noted, carried huge sail areas and very reduced complements. Today, modern sail materials eliminate the need for on-board manufacture of new sails and much of the sail maintenance and repair that took up the time of square rigger and schooner sailors of yore.

Yet, for certain trade routes and perhaps also for "underdeveloped" areas, we may wish to make the sail-handling aspects of a ship relatively labor-intensive. One might do likewise also in other area to expand the labor market with a new class of jobs of unique appeal: sailing fast over the world's oceans in a style that even multi-millionaires can scarcely afford nowadays.

Directions for Further Research — and Action

The Michigan study made suggestions for further research, particularly in these areas:

- ☐ Model testing (tank and wind tunnel) of both hull and rig
- ☐ Optimization of sailing ship design through parametric studies
- ☐ Sail plan optimization, including alternatives to the square rig
- ☐ Potential use of weather routing
- ☐ Reduction in uncertainty of construction costs
- ☐ Operational procedures in typical ports
- ☐ Detailed investigation of one particular route

All of this work is desirable, and indeed most of it is included in our program. We believe, however, that the demonstrated success with fore-and-aft schooner rigs on large commercial sailing ships, coupled with developments in rigs, materials and operating modes, enable one to postulate advanced ship performance characteristics with reasonable accuracy without further tank and wind-tunnel tests at this stage.

Furthermore, an integral part of our program is to test — in a suitable computerized model — the effect of modifying ship characteristics on ship operating economics over a broad spectrum of trade routes and commodities. This model, which is shown schematically on page 32, embraces not only ship

characteristics and their effect on ship voyage speeds but also modifications or variations in weather and ship and operating costs as well as commodities and specific trade routes. It will allow us to identify the most promising features and refine our conclusions before commiting the effort to a hardware development program — at whatever scale appears to be most practical. Equally practical, the model and modeling results would serve as a "standard reference" in evaluating the economic potential of proposed changes in characteristics and parameters that might be suggested by subsequent research and testing at sea.

With respect to testing at sea, we have been most interested to find that one thoughtful and courageous entrepreneur, Hugh G. Lawrence of Sausalito, Calif., is in the final stage of fitting the *Patricia A*, a former Baltic trading schooner of 400 deadweight tons, with a modern fore-and-aft rig. He plans to put the 170-foot vessel in regular trans-ocean trade, thus testing its economic viability in the real world. The *Patricia A* will be well instrumented, and we hope to obtain, as our program is activated, data collected during the *Patricia A*'s voyages to be used as inputs to our computerized model for comparison with predicted performance based on ship characteristics. We also hope to obtain similar inputs from other sail-powered research and training vessels and large yachts; these data will be useful in refining the optimum parameters for sea-going prototype vessels.

Will a conversion to sail power for cargo ships actually take place? How soon can it be carried out? While feasibility must be confirmed by rigorous analysis, inspired design, and proof in practice, we are optimistic and our answer to the first question is: "definitely." And our program projects a time frame for action:

The studies of trade routes, commodities, preliminary designs, and cost and economic analyses should require about one year. About two and a half years might be needed for the design, construction, test, and commercial evaluation of two prototypes. If such a program were implemented now, full-scale trans-ocean ships could be sailing in commercial trade by 1984.

Lloyd Bergeson is an industrial management consultant. He has been general manager of two major shipyards — the Quincy Shipbuilding Division of General Dynamics Corp. and the Ingalls Shipbuilding Corporation. Earlier, he directed the planning and production, material, and cost control activities of General Dynamics' Electric Boat Division during the development of land-based, prototype nuclear power plants and the world's first eight sea-going nuclear submarine prototypes. He coordinated all Electric Boat activities in the development, design and construction of the first *Polaris* missile submarine, the U.S.S. *George Washington*. At Quincy, he was responsible for developing and marketing the world's first 125,000–cubic-meter liquefied natural gas (LNG) tankers. He has planned or directed the engineering design and construction of 20 different classes of major commercial and naval ships. In addition, he has provided consulting and management services for a wide variety of commercial development projects, including solid state and cryogenic devices and equipment, jet engines, chemical process plants, and 1,000-megawatt nuclear power plants. A life-long yachtsman, he has cruised and raced extensively over the last 40 years and in 1978 made a single-handed passage under sail from North America to Norway. He graduated from M.I.T. in 1938 with a S.B. degree in naval architecture and marine engineering.

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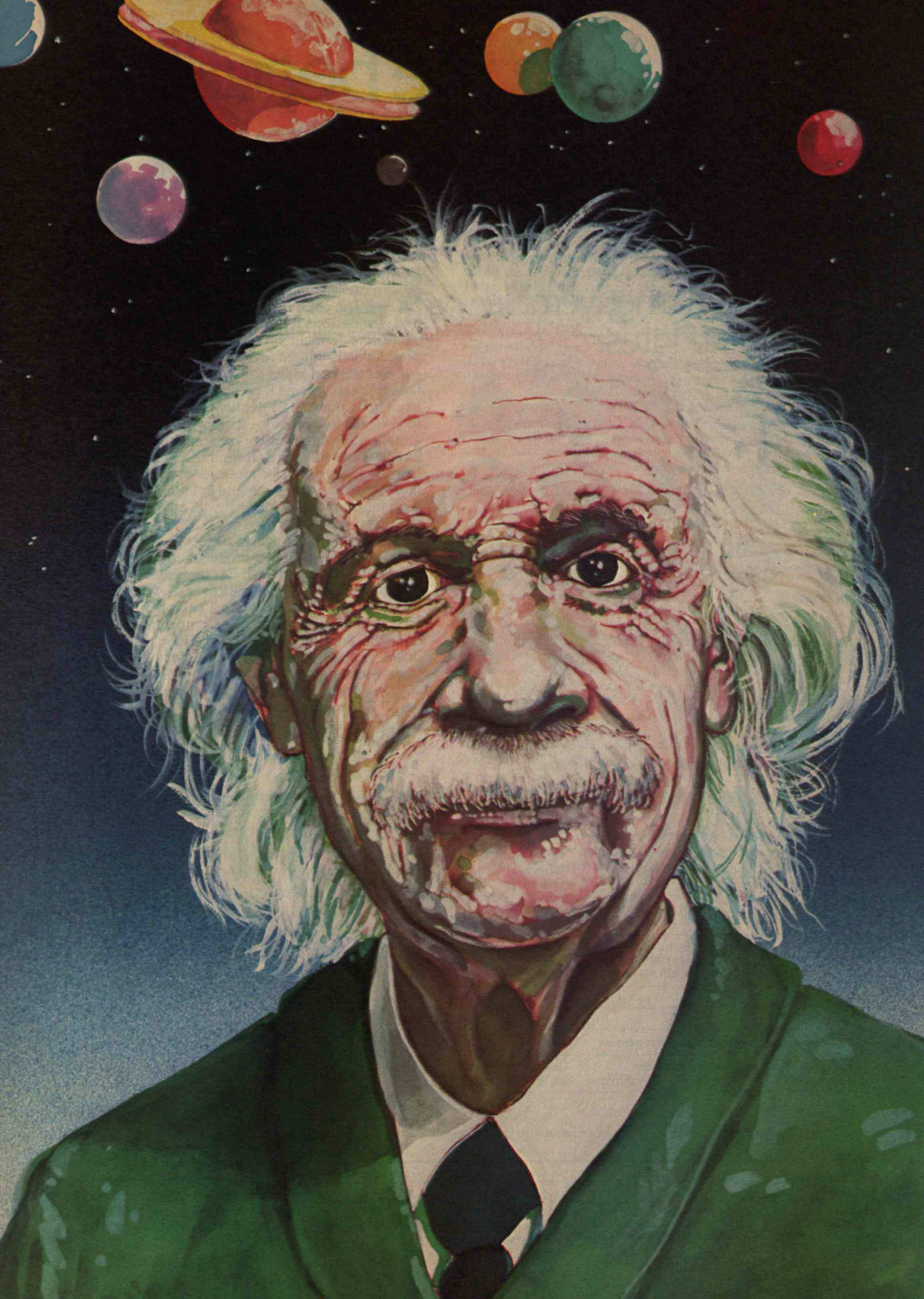

Relativity Theory and Gravitation

by Hermann Bondi

To commemorate his hundredth birthday — March 14, 1979 — here is a thought-experiment, first discussed by Albert Einstein, to reveal the deep connection between gravity, light, and time.

The essential characteristic feature of gravitation was discovered by Galileo, namely that all bodies fall (i.e., accelerate) equally fast at a given place. "Galileo's principle," as we may call it, has been tested with very high precision. Early in this century Eötvös (1908) established its validity with an accuracy of one part in 10^8, and more recently Dicke (1962) has driven the precision to the astonishing level of one part in 10^{11}. Thus it is entirely reasonable to try to establish the consequences of the assumption that Galileo's principle holds exactly.

The contrast with other forces is profound. In every other case there is a property that bodies may or may not have that determines whether a force does or does not act on them. Thus an electric field acts only on bodies that have electrical characteristics (charge, dipole moment, etc.). Remove these, and the force disappears; strengthen them, and the force increases. (It is true that on an atomic scale matter is necessarily electrical, but if we confine our attention to bodies no smaller than specks of dust these complexities disappear.) In much the same way the response of a body to a magnetostatic field is wholly determined by its magnetic characteristics. With most materials there is little difficulty in reducing their magnetic response to very low levels indeed.

Gravitation is unique in acting not on any abolishable property of a body, like its charge of magnetic moment, but on its inalienable feature of inertia. For inertia (or mass) is, by Newton's second law, that by which force has to be divided to yield acceleration. If all bodies have the same acceleration, the forces on them must be proportional to their inertial masses. Thus inertia or mass, the very feature by which we recognize a body as a body, is also that which responds to gravitation.

Gravity and Observation

At first sight the equability of the response of all bodies to gravitation appears to be a simplifying feature. But in fact the opposite is the case when we try to *observe* gravitation. Perhaps an analogy will help. Imagine a world in which all materials had the same coefficient of thermal expansion. How would you then construct a liquid-in-glass thermometer?

Of course we are all aware of gravitation; standing makes our legs tired, we can measure our weight on scales, etc. But these are all means pretty well confined to the surface of the earth where we happen to live. Gravitation as a *universal* force (Newton and

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Illustrations: Jon McIntosh

the motion of the moon!) must be measurable *everywhere,* and our position on the surface of a massive body, the earth, is highly atypical of the universe, most of which is empty. How does one observe gravitation in empty space? Since everything falls the same way, nothing measurable seems to be left. We are nowadays familiar with the weightlessness of astronauts in an orbiting spacecraft, we know very well that they cannot measure their masses by stepping on scales, and that the soup floats around in drops. So, to all appearances, there is nothing measurable left of gravitation in space. Are we thus talking about a pseudo-force, one which can be observed if one has solid ground under one's feet but not otherwise, e.g., in space?

A closer analysis shows this pessimism to be misplaced. Though all bodies fall equally fast, this common acceleration varies with position. Consider a spacecraft in orbit near the earth (as in the figure on page 42) and remember that it is of finite size, small though it is compared to the scale of its orbit. The acceleration of free fall at the point of the spacecraft closest to the earth is higher than in its middle, where it is in turn higher than at the point of the spacecraft farthest from the earth. There will therefore be a stress on the spacecraft trying to elongate it along the line joining it to the center of the earth. While the structure of the spacecraft will easily be strong enough to resist this stress, specks of dust near the part of the spacecraft farthest from the earth will tend to drift farther that way, for they will fall with the local acceleration which will be marginally less than the "compromise" acceleration adopted by the spacecraft as a whole. Similarly, dust near the part of the spacecraft nearest the earth will fall a little faster than the spacecraft. Thus the astronaut will observe dust to settle in two portions of the spacecraft, farthest from, and nearest to, the earth. From this fact he will be able to infer that he is in a gravitational field. (Indeed, this effect has been used to engineer a "gravity gradient" stabilization for certain spacecraft.)

We can easily transfer this consideration to "spacecraft earth" in its orbit round the sun. While we cannot feel directly the enormous gravitational pull of the sun, since we and the earth under us are all falling towards the sun equally, the "softest" parts of the earth, namely the oceans, respond to the aforementioned effect by elongating the sphere of water both toward and directly away from the sun, producing the solar tides. (The somewhat larger lunar tide is produced in just the same way, but the different ratios of distances and masses render the visualization a little harder.) Thus, although there is no direct observable effect of the sun's field, the tides are a plain demonstration of its non-uniformity, and we could deduce from them the existence of the sun (and the moon) even if we could not see them.

Thus everywhere there may be measured an observable of gravitation through the fact that although different particles fall equally fast if they are in the same place, there is a difference in their accelerations if they are in different places, even if these are close by. *Thus the universal observable of gravitation is the relative acceleration of neighboring particles.*

Since this relative acceleration will be small if the particles are near to each other, and tends to zero as they tend towards coincidence, it is reasonable to suppose that this relative acceleration depends linearly on the separation. Since both the separation and the acceleration have direction as well as magnitude, we are talking about a rather complex linear relation, in which different directions are by no means equivalent. (What would have happened if instead of choosing the parts of the spacecraft nearest and farthest from the earth, we had chosen the leading and trailing parts?) The important point, however, is not this complexity, but the fact that it is *only* this non-uniformity of the field that is observable everywhere. A field in which the acceleration is the same throughout, both in magnitude and in direction, is *unobservable* and should thus not be regarded as a field. Hence we arrive at the following conclusion: since in physics we always define quantities by how we measure them, *a gravitational field is a relative acceleration of neighboring particles.* If this relative acceleration vanishes we do not have a field.

(The reader should note that in other presentations there may be the concept of a "uniform gravitational field," i.e., one where the acceleration is the same throughout the field. According to the analysis here this would be described as a zero gravitational field.)

While our definition is universally applicable, it may leave the reader wondering whether this relative acceleration is what makes one's feet tired when one stands around too long. What in fact happens with a solid earth (as with the rigid spacecraft earlier) is that it integrates these small relative accelerations through its body, leading to a substantial difference in acceleration ($2g$) at opposite ends of a diameter of the earth, or g between its surface and its

center. The earth as a whole, though massively compressed by all these effects, moves with its center effectively in free fall (toward the sun). The integrated difference g is thus what we feel. (Of course, there is no appreciable change in its magnitude between our head and our toes, but we are conscious of g because the ground prevents us from falling freely.)

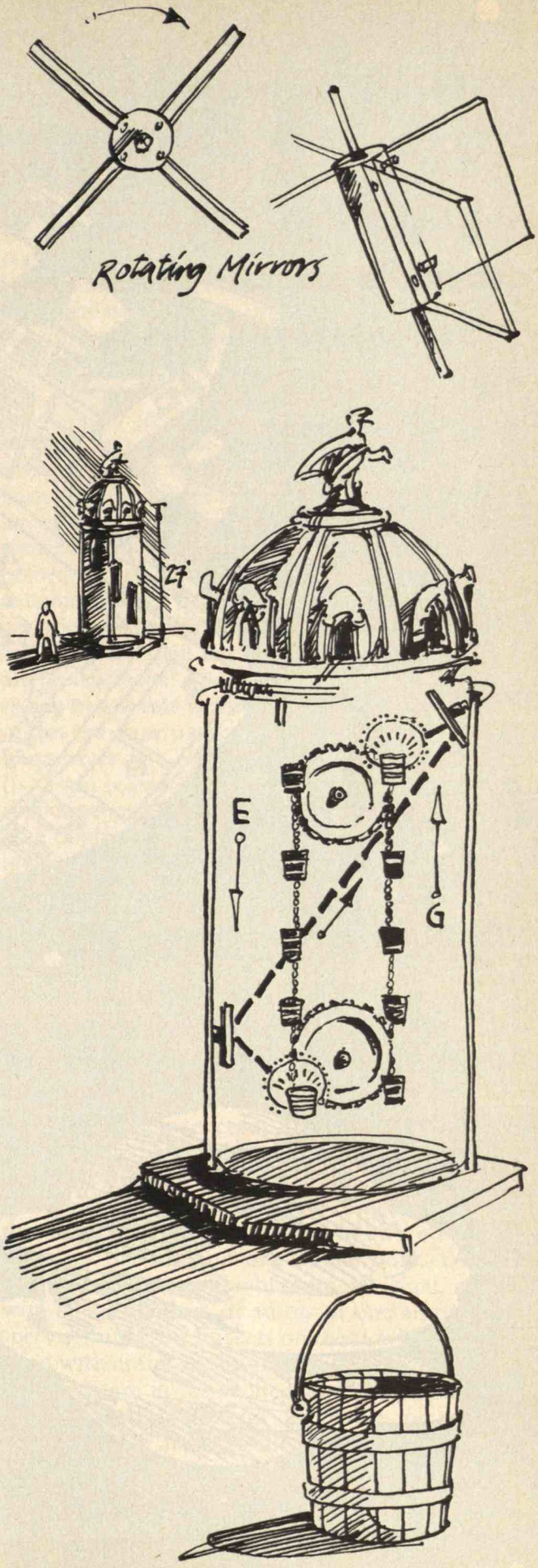
Types of Mass

Now *reciprocity* is a universal feature of physics and in dynamics is described by Newton's third law, of the equality of action and reaction. Thus, mass being what gravitation acts on, mass must also be that which *produces* gravitation, just as electric charge generates an electric field. Neither mass nor electric charge can vary arbitrarily; both satisfy a *law of conservation*. Important though this constraint is in the electrical case, it is even more significant in the gravitational case because electric charge of both signs exists, but *we know of no negative mass*. Thus we may have an electric field generated by separated equal and opposite charges and, by bringing them to coincidence, we can wipe out both source and field. The absence of negative mass makes this impossible in the gravitational case, leading to a remarkable permanence of the sources and therefore of the fields. Moreover, the law of conservation of momentum (which has no parallel in the electric case) further constrains the motion of the sources.

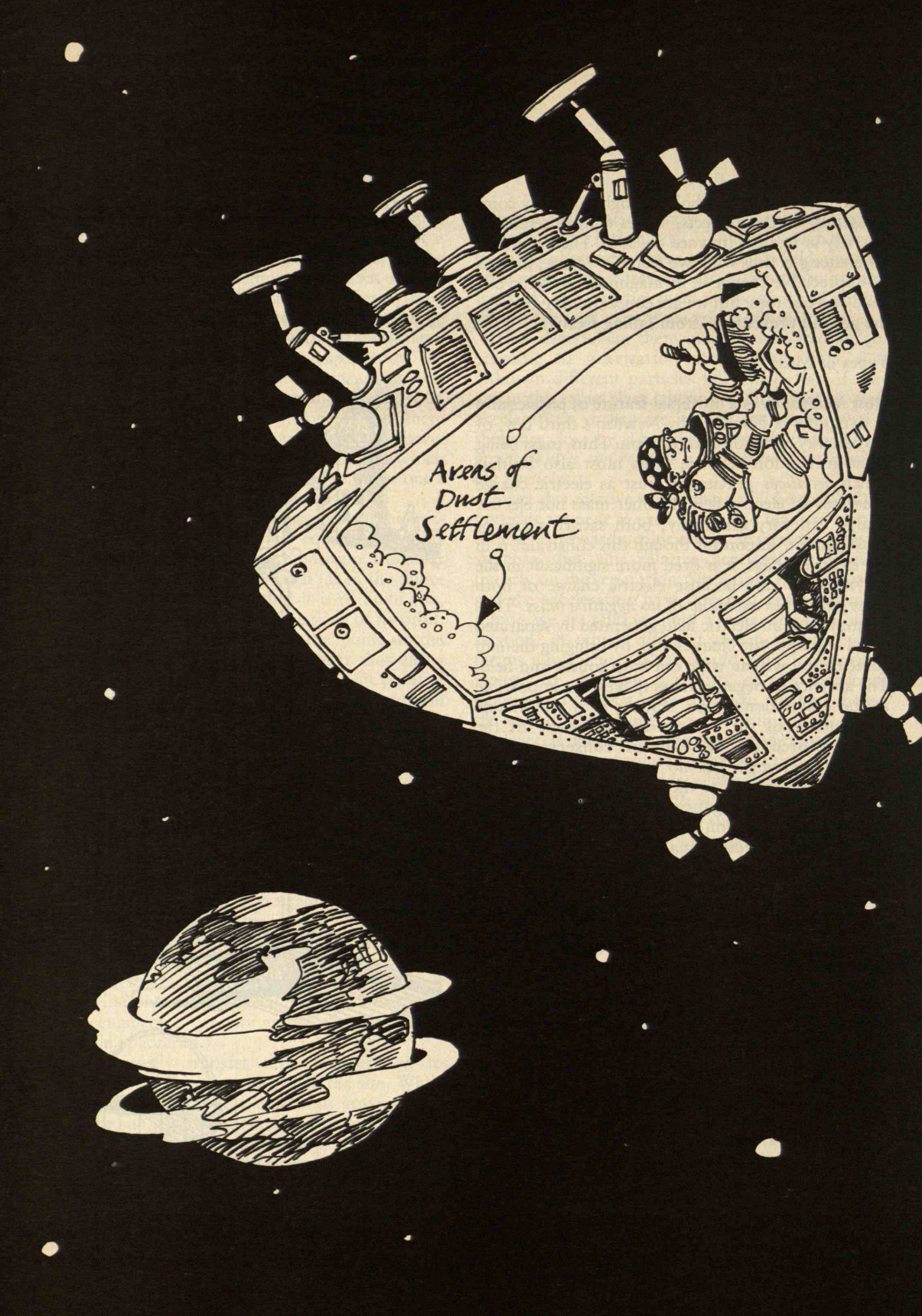
Why is there no negative mass? Before attempting to answer this question it may be worthwhile to distinguish three kinds of mass, each defined, as any physical quantity should be, by the method of measuring it:

(i) Inertial mass, measured by the acceleration produced by a known force, or the velocity by a known impulse (e.g., response of a ball to a paddle).

(ii) Passive gravitational mass, i.e. that property of matter that the gravitational field hooks onto. This may be measured by the force produced in a known gravitational field, as by weighing a body on a spring balance at the earth's surface.



Buckets of atoms shuttle forever in a perpetual-motion machine that cannot possibly work. The fault in the reasoning gives insight into the physics of Einstein. Buckets ascending at the right side of the experiment are in their lowest or "ground" state of energy; those descending at the left are excited. As each bucket reaches the nadir of the device, it gives up its excess energy (and also, by $E = mc^2$, its excess mass), which is transmitted by a system of mirrors to the bucket arriving at the top. In a later experiment, the set of rotating mirrors shown in the inset is substituted for the mirror at the top.


Areas of
Dust
Settlement

(iii) Active gravitational mass which *produces* a field, measured through observing the orbit of a body in its field (e.g., the mass of the sun can be deduced from the motion of the earth and a knowledge of the sun-earth distance).

By Galileo's principle, (i) = (ii), and by Newton's third law (action equals reaction), (ii) = (iii). Thus if any mass is negative, all are negative. A negative inertial mass would be strange, for such a body would come toward you if you pushed it away, and move away if you pulled it toward you. Not perhaps inconceivable, but we may be pleased at not having discovered any such material.

Buckets of Atoms

Newtonian mechanics, however excellent at describing velocities small compared with that of light, ceases to be logically or experimentally tenable at high velocities. In particular it is quite impossible to make the gravitational theory just described cover the motion of light in any credible sense.

The special relativity of Albert Einstein, on the other hand, is known to describe perfectly, in the absence of gravitation, both mechanics at all speeds and the propagation of light. It is reasonable to assume that when weight is abolished, as in an orbiting spacecraft, at least the main principles of special relativity will still apply within this modest volume. However, a difficulty immediately presents itself if we then try to describe gravitation through the Newtonian observable. For if the relative acceleration of neighboring particles were independent of velocity, it would be possible to arrange the particles and their velocities so that one of them was accelerated from below to above the speed of light, which is forbidden by special relativity. Thus the relative acceleration of neighboring particles must depend on their velocities, but to get agreement with Newtonian theory for small velocities this dependence must be negligible for such small speeds.

Of more immediate physical significance is an ideal experiment, first discussed by Einstein, which reveals the deep connection between light, gravitation, and time that emerges when well-established features of relativistic and quantum physics are linked to Galileo's principle. These features are:
(i) Atoms of any one species have a well defined set of states, each identifiable and of a particular energy, the state of lowest energy being called the ground state. For our purposes it is sufficient to focus attention on this and on one other state (called excited).
(ii) Light of any given frequency (i.e. color) exists only in units (photons) whose energy is a universal constant times their frequency.
(iii) When an atom makes a transition from the excited to the ground state, the energy lost by it is radiated as a photon of this energy (and therefore of the appropriate frequency). Conversely, light of this frequency (and therefore energy) can be absorbed by an atom in the ground state. Though, in general, some blurring of the sharpness of the frequency concerned occurs, due to momentum and other effects, suitable choices can make this blurring very small and then the excellent definition of frequency is used for our best time measuring devices (cesium and ammonia clocks). Indeed the elasticity of the balance spring of a watch is controlled by interatomic forces of just the same nature as the atomic forces defining frequencies.
(iv) Light reflected by a moving mirror shows a shift of frequency (Doppler shift) which is toward the blue (higher frequencies) for an approaching mirror and toward the red for a receding mirror.
(v) Like other physical quantities, time is defined by the means used to measure it, i.e., clocks.
(vi) Light exerts on a mirror a well-defined pressure which, while small in laboratory circumstances, is nonetheless readily measurable.
(vii) Energy has mass, by Einstein's well-known equation $E = mc^2$. This is a thoroughly tested relation. Though in our case the difference is too small for measurement, there is no doubt that the mass of an excited atom exceeds that of an atom in the ground state by precisely the amount corresponding to its extra energy.

With this preamble, we now consider a tower on the earth, with an endless chain of buckets linking a wheel at the top and one at the bottom (see the figure on page 41). The buckets, all equal, are filled with equal numbers of atoms of one and the same species, but all the buckets on the side labelled G are filled with atoms in the ground state, while all those on side E are in the excited state. Since the excited atoms have more energy (available for release as light) than the atoms in the ground state, they have more mass and thus, by Galileo's principle, more weight. Side E is heavier than side G and, with sufficiently freely rotating wheels, will begin to move downward, with side G going upward.

Dust accumulates at the places in an orbiting spaceship nearest to and farthest from the earth, thus revealing to an astronaut that his craft is in a field of gravity. Details are given in the text on page 40.

We now induce the excited atoms, as they arrive at the bottom, to make the transition to the ground state, emitting light of the appropriate frequency in the process. Thus as the buckets arrive at side G, the atoms in them will be in the ground state, like the atoms already on side G. The light emitted at the bottom is caught by a suitable arrangement of fixed mirrors, producing a beam travelling to the top of the tower which is there focussed on the atoms in the G buckets arriving at the top. Since (by [iii] above) the frequency emitted by an atom making the transition from the excited to the ground state is just right to be absorbed by an atom in the ground state, making it thereby excited, our arrangement will ensure that the situation remains as in the figure. Thus side E will always contain excited atoms, side G atoms in the ground state, and hence the chain will keep moving driving the wheels and yielding energy, with no recognizable reaction on the field of gravity or on its source, the earth. Thus we have devised a *perpetuum mobile,* generating energy from nothing. As this is known to be impossible, there must be a mistake in the argument. But where? Every step seems sound and tested by experiment, directly or indirectly (see [i], [iii], [vii] above). So how can a contradiction have arisen?

The Einstein Shift

The one possible chink lies in the reciprocity of (iii). Though we know that an atom changing from the excited to the ground state emits light of just the right frequency to be absorbed by an atom in the ground state, thereby making it excited, this has only been established *with the atoms side by side.* Perhaps this does not work if the emitting atom is at the bottom of the tower and the absorbing one on top. If the frequency of the light on arriving at the top were too low (i.e. if it were too red) the photons would have insufficient energy to excite the atoms there and thus our *perpetuum mobile* would not work. (If the frequency on arrival at the top were too high, the light could excite the atoms easily and the problem would persist.)

How can we test this ingenious way out? If the only reason the system does not work lies in the light being too red on arrival, giving it an appropriate blue shift could return it to the right frequency and thus would make the system work again. Since reflection from an approaching mirror causes such a blue shift, we fit a wheel of mirrors at the top of the tower (again consult the figure on page 41) and spin it so that the incoming light is blue-shifted by this reflection. At the right speed of rotation, the reflected light should now have the correct frequency to excite the atoms arriving at the top, so that the system can work and deliver energy. However, we need energy to keep turning the wheel of mirrors against the pressure exerted on the mirrors by the light. Thus the answer is clear. The red shift of the light is such that in moving the mirrors to compensate for it, the wheel of mirrors uses up exactly the energy produced by the chain, since energy can be neither created nor destroyed.

Thus we can calculate this gravitational red shift — the "Einstein shift," — which turns out to be a fractional lowering of frequency by gh/c^2, where g is the acceleration of gravity at the surface of the earth, h the height of the tower erected on the surface of the earth, and c is the speed of light. With a tower 27 meters high, for example, this is 3×10^{-15}, a very small number indeed. Generalizing our formula, it turns out that for light emitted on the surface of the sun and received here on earth the shift is about 2×10^{-6}. For many years, efforts at observing the Einstein shift therefore concentrated on comparing the frequencies of spectral lines from the sun with those of the same lines produced in the laboratory. The great differences in conditions of line production (density and temperature of the gas concerned) unfortunately introduced other, and larger, shifts which cannot be calculated accurately. Thus the test of the shift had to wait until the exceedingly sharp gamma-ray lines produced through the so-called Mossbauer effect, in which the atoms emitting or absorbing photons lie in crystal lattices at low temperature, finally enabled Pound and Rebka in 1960 to verify the theoretical predictions on earth, actually using a tower of about the height quoted above!

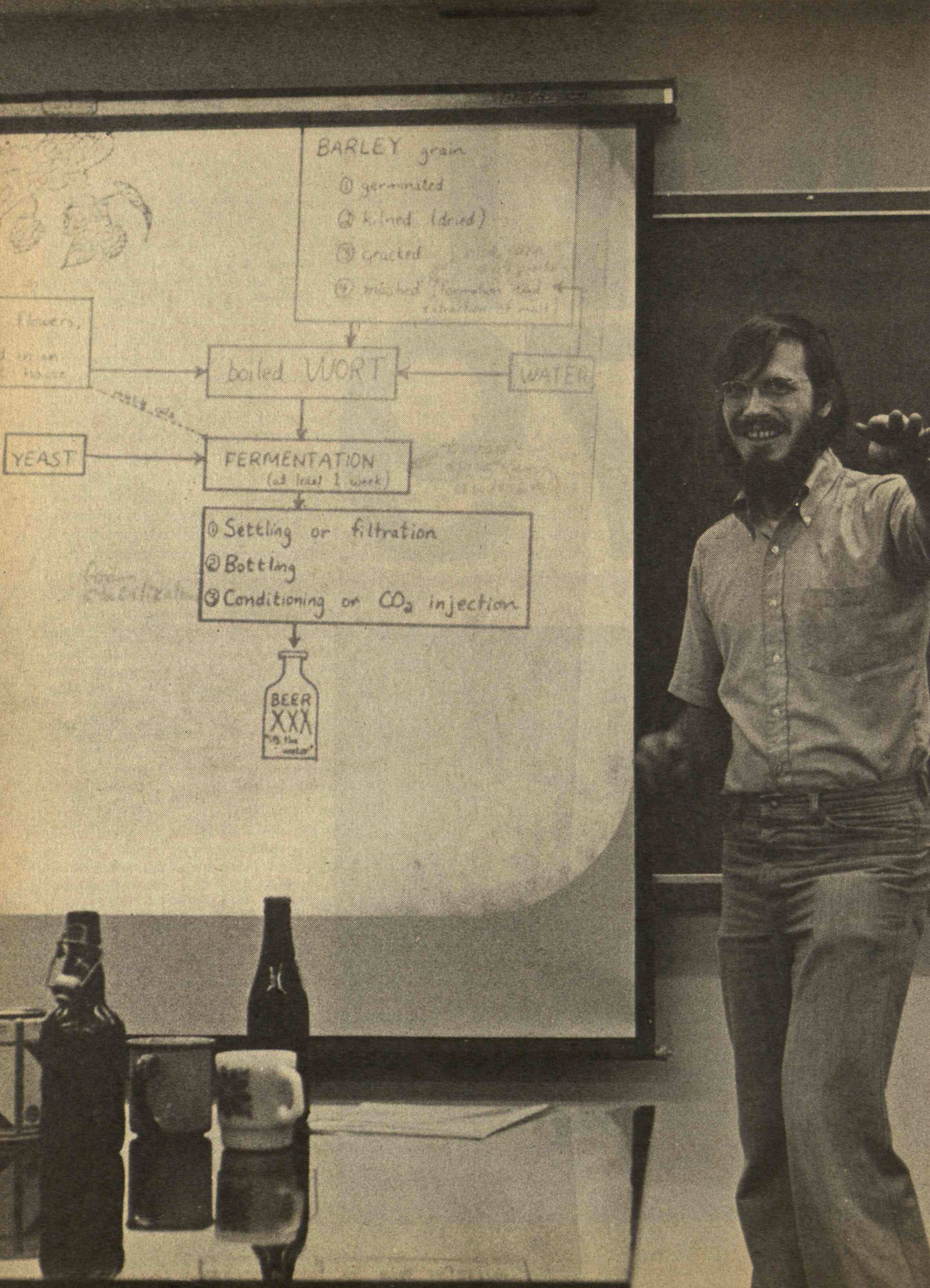
Though the gravitational red shift is small, at least in all readily accessible situations, its mere existence has considerable consequences. It is therefore well to remind oneself that the theoretical derivation of the effect is not only logically compelling, but also requires only those parts of relativity and quantum physics (see [i] to [vii] above) as have the most solid direct or slightly indirect experimental backing, and that moreover the effect itself has been tested with considerable precision.

The first major consequence arises from (v). A spectral line may be something sounding a little ethereal, but in fact it is *the* means of measuring time. Also, whether one is talking of a superaccurate cesium clock, a quartz-controlled clock, an ordinary

MIT '79

Small wonder if he's a bit bemused: electrical engineer Dave Dudley has been transported magically into the past, where he is embroiled in the schemes and intrigues of a wizard's three daughters. That's the plot of Loved and Lost, or That Old Hack Magic, *a one-act play by graduate student Michael Kirkish, performed early in February in Kresge Auditorium. It was the first Tech Show in ten years. Dave Dudley was played by Jerry M. Stringham, 81.*

Tech Show — musical comedies by M.I.T. students — started in 1899 and reached its height in the 1920s, with annual budgets of up to $20,000. Its charter was revoked in 1936; in 1947 it was successfully revived, this time until 1968. Now, under the auspices of the M.I.T. Musical Theater Guild, Tech Show has been revived again, and a full-scale production is planned for spring of 1980 or 1981. (Photo: Gordon R. Haff, '79).


BARLEY grain
① germinated
② kilned (dried)
③ cracked
boiled WORT
WATER
YEAST
FERMENTATION
(at least 1 week)
① Settling or filtration
② Bottling
③ Conditioning or CO_2 injection
BEER
XXX

During I.A.P. it's difficult — and unnecessary — to separate the serious from the frivolous. Professor Edward A. Boyle, Ph.D. '76, gave a lecture on "The Geochemistry of Beer." Of course, lectures can sometimes be rather dry; so the session adjourned to a campus pub in order to sample the subject matter. (Photo: Gordon R. Haff, '79)

Time for Everything — and Anything — that Doesn't Fit the Rest of the Year: Independent Activities Period

It wasn't a regular school term — but people were taking classes, attending lectures, participating in seminars. It wasn't a vacation — but some students were traveling, working at temporary jobs, or just staying home.

What was it? January at M.I.T.: Independent Activities Period, three-and-a-half weeks of the academic calendar during which almost anything can happen.

Although it's a formal part of the Institute's schedule, I.A.P. is kept as unstructured as possible. Students may do whatever they wish — take part in the organized activities (over 700 different ones this year), create their own projects with faculty members, or, if they want, take the month off. Activities can be on any topic, and they're organized and attended by anyone at the Institute who's interested.

When the "Routine" is Not Commonplace

I.A.P. is only in its ninth year, but it's already an accepted part of the Institute's rhythm — Joel West, '79, wrote in *The Tech* that this year's I.A.P. was "routine." Perhaps the wide range of possibilities is no surprise; but the activities themselves are still colorful and unpredictable. Here's a taste of I.A.P. 1979:

☐ An enormous Polaroid Land camera — there are only four like it — was installed in the Hayden Gallery, transforming the gallery into a photographer's studio for I.A.P. Students and local artists made large (20 by 24 inch) color photographs, as visitors to the gallery watched — and sometimes became the subjects of the pictures.

☐ Former Massachusetts governor Francis W. Sargent, '39, joined a panel discussion with local newspaper and broadcast journalists for a talk about "Politics, Policy, Humor, and Satire: What Makes Politics Funny — Massachusetts and Elsewhere." Mr. Sargent said that humor and satire were as important for politicians as for journalists. When he was governor, he said, his desk had a plaque which read, "Don't ask me . . . I didn't go to Harvard."

☐ A team of Hillel members won the M.I.T. College Bowl this year. "We took several big risks at the end," said Michael Stiefel, a graduate student in nuclear engineering; "the cones could have been rods." (The question was: What term denotes a part of the eye and a geometric solid known to children?) Mr. Stiefel said he chose "the one that came to my mind first."

☐ The Organization of Arab Petroleum Exporting Countries declared a total oil embargo on all Western countries until Israel withdraws from all occupied Arab territories; in response to this move Europe prepares to invade Northern

For I.A.P., Alumni and Students Make the "'Tute Connection"

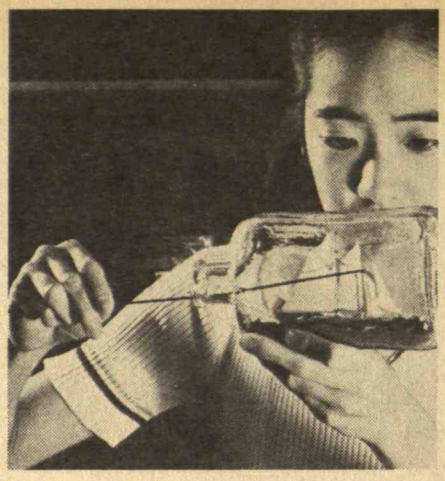
"No matter what, M.I.T. is part of you and you're a part of M.I.T.," Claude W. Brenner, '47, told students at an I.A.P. event sponsored by the Alumni Association, of which Mr. Brenner is a Vice President.

"Alumni and the 'Tute Connection" was offered during I.A.P. 1979 for the fourth year. More than 100 students, alumni, and staff members of the Alumni Association ate pizza and listened to active alumni discussing their motivations, as varied as the speakers themselves.

Alumni activities make the relationship with the Institute "a two-way street," said Klaus Kubierschky, '64, former president of the M.I.T. Club of Boston. Marjorie Pierce, '22, noted that the Association of M.I.T. Alumnae (A.M.I.T.A.) "keeps us in touch with the excitement of the Institute." Alumni clubs keep alumni abreast of M.I.T. research.

Memories of their own survival of their college years leads many alumni to provide services to current students. Charles E. Kolb, Jr., '67, a member of the Committee to Strengthen Alumni Involvement with the Institute chaired by Mr. Brenner, pointed out that M.I.T. can provide only one kind of role model for students: research professors at a major university. "That's not applicable for most students. I try to arrange for alumni to meet students and tell them what it's like to leave and go out on your own," said Mr. Kolb. A.M.I.T.A., according to its president, Dr. Susan L. Kannenberg, '61, welcomes students to its meetings and seeks "to bring home to especially women students but also men students that there is a wealth of professional and industrial careers."

Mr. Brenner said that "alumni work keeps M.I.T. forceful, viable." Even if the importance of that role does not appeal to future alumni, "Alumni and the 'Tute Connection" provided those present with yet another reason for participation: alumni work is fun. — *Elizabeth Greene*



Meeting the Policymakers in Washington, D.C.

Students from M.I.T. were invited to visit with science and technology policymakers in Washington, D.C., in an I.A.P. activity sponsored by the Program in Science, Technology, and Society. Joel West, '79, went along for the trip, and makes the following report.

Reality — or an overdose of it. That's my impression of a three-day visit to hear policymakers in Washington, D.C.

At first, all I could see was what I'd heard all along: how frustrating it is to deal with such a mammoth, sluggish system. The various speakers were quite candid about the unpleasantries of their jobs. One put it bluntly: "You have to be able to work and manipulate the bureaucracy; if you can't do that, you can't be effective."

In Washington, imperfection is accepted as a reality of life. People who have worked with the system and understand it place an emphasis on getting *some* results — and though the results aren't quite what they ought to be, if the process by which they were reached was fair and just then that's the best one can humanly expect.

That's a very different perspective from what we're used to at M.I.T., where one is encouraged to do one's best work, to fine-tune everything, to keep at it until it's perfect. The emphasis is on the purity of results: while success is measured in terms of the end result, it can only be obtained in the context of a fixed process — what we know as the scientific method. Deadlines can be postponed, courses can be graded "incomplete," no rule or requirement is totally inflexible. On the other hand, it's hard to tell a combat soldier without a rifle or a welfare mother without food for her children, "Sorry, your appropriation isn't ready yet — can we get back to you next week?"

If the system is so trying, so exacting, and yet so imperfect, how can anyone (especially a scientist) stand to work in or around the government? In all the people we saw, from the congressional aide to the assistant commerce secretary who was my host, was one thing in common, an answer surprising in its simplicity. Yes, they all believed in working within the system, but the answer was even simpler than that: each was where he was, and stayed where he was, because that was what he believed in.

As one put it, "the government is not a monolith." It may be wasteful, too pervasive or too passive, but it is still a collection of individuals, each with his or her own individual goals and beliefs.

A potpourri of I.A.P. activities (counterclockwise from center of this page): metal sculpting; lecturing on political humor (former Massachusetts governor Francis W. Sargent, '39, watches as Daniel A. Nathan, '79, accompanies singing journalist Jack Cole); discussing the Versator II Tokamak Plasma Device; learning the physics of piano tuning; building a boat in a bottle; making bamboo pipes; and teaching the computer language Lisp. (Photos this page: Gordon R. Haff, '79; center, facing page: Steven L. Solnick, '81; others, facing page: Calvin Campbell)

Below: Professor E. McSquared led the way through the 1979 Guide to I.A.P.; he's star of Professor E. McSquared's Original, Fantastic & Highly Edifying Calculus Primer, *by H. Swann and J. Johnson; Los Altos, Calif.: William Kaufman, Inc. (Illustration: John Johnson, ©Teapot Graphics)*

Africa and the Soviet Union masses troops on the Iranian border. It happened in a simulation of political crises — a sort of war game using real historical events up to the point of the hypothetical conflict. This year, China was the winner (with Japan a close second) by capitalizing on the economic climate of the crisis.

☐ "Seabrook Week" — a series of lectures, films, and panel discussions followed by a tour of the construction site of the Seabrook Nuclear Plant — took on the challenging and complex questions of nuclear power: speakers from both pro- and anti-nuclear were invited to present their sides of the issue.

☐ Students overflowed the classroom where "A Radical Introduction to Lisp" was being taught. They wanted — and received — an alternative to the way the computer language is studied during the regular semesters. The Student Information Processing Board organized the course and provided computer time; they say their approach that is neither too "mathematical" nor too "functional."

☐ Six hours a day, four days a week, for three weeks — total immersion in the Mechanical Engineering Project Laboratory. It's a term's worth of work, but for some people this was an intriguing — and possibly better — way to do it.

☐ Something called "A Modest Introduction to Crayons." Its listing in the Guide to I.A.P. said the activity would "focus mainly on the interaction of the individual with his crayons, rather than on the actual production of crayon art." The meeting in the middle of January yielded a two-story-high poster — a group doodle — that's now hanging in the lobby of Building 7. — *L.A.*

After their 30th anniversary concert (see below), the M.I.T. Concert Band began their winter concert tour at St. John's College High School in Washington, D.C. Shown here, Jeffrey A. Fried, '82, performs a solo on the euphonium — a small tuba —as director John Corley conducts. (Photo: Joel West, '79)

Thirty Years of the Concert Band

It was in 1953 that John Corley and his M.I.T. Concert Band decided to concentrate solely on performing original works written for band: none of those "special arrangements" to turn familiar songs or symphonies into a medium for which they weren't intended.

Twenty-five years later they're still at it, and late last year they celebrated their commitment with a special concert — it was also the 30th anniversary of the founding of the band back in 1948. The program included four premieres — "Rocky Point Holiday" by Ron Nelson, "Fantasia" by Gordon Jacob, "Reflections on Paris" by Fisher Tull, and "Russian Christmas Music" by Alfred Reed — and at least one piece with special nostalgia for some in the audience: "Suite from 'The Social Beaver' " written in 1960 by Andrew Kazdin, '63, to accompany a film produced by M.I.T. Mr. Kazdin, who was tympanist for the Concert Band and Symphony Orchestra, is now executive producer for Columbia Masterworks.

Two Sailboats Join the Fleet

The fleet at the M.I.T. Sailing Pavilion will be larger by two sailboats this spring, the gifts of alumni. Harry Duane, '57, is the donor of an International 470, representing one of the classes raced in the Olympics; it will be a valuable resource for training sailing teams. And Ragnar Naess, '23, has given a Laser, raising Tech's fleet of this popular singlehander to five.

M.I.T.'s total sailing fleet now stands at 65, the largest number in history.

For "Loners" and Transfers

For some, it's simply a matter of making the best of adversity; for others, it's a matter of choice.

"The advantage of being a commuter is that you can get away from the Institute every day," Carl Ruoff, '79, told Steven Schwartz, '78, of *The Tech;* he's chosen to live in a Cambridge apartment since his freshman year, and he's made the choice very deliberately: if you don't have to live with fellow-students 24 hours a day you can be more tolerant of them, says Mr. Ruoff, and more friendships develop.

But for others — mostly transfer students who enter M.I.T. as sophomores or juniors — living off-campus is a disadvantage made necessary by a shortage of on-campus accommodations.

For both groups, the Nonresident Student Association (N.R.S.A.) and its house at 311 Memorial Drive are important resources. There's a kitchen, study and sleeping rooms, and a sort of social center — "a place to hang out," says Joseph Kulik, '79, president of N.R.S.A. "I made my best friends here," says Timothy Bliamptis, '79, vice president of N.R.S.A.

C. G. Eliot

A Rhodes Scholar from Canada

Charles G. Eliot, '79, will go from M.I.T. to Oxford University next fall with a Rhodes Scholarship in hand — the first winner from the Institute of the prestigious international award since 1977.

Mr. Eliot was one of 11 Canadian recipients announced during the winter; he is from Dorchester, New Brunswick. Mr. Eliot's M.I.T. major is chemistry, and he'll work for his doctorate in nuclear magnetic resonance, probably at Wadham College.

Rhodes Scholars must demonstrate outstanding qualifications in four areas — intellect, character, leadership, and physical ability. Mr. Eliot's M.I.T. record is appropriately impressive: he's a member of the Shakespeare Ensemble, plays in the Early Music Society and Chamber Music Society, holds a varsity letter in track, is a published poet, and speaks Greek. (He spent two years studying music at the National Conservatory of Greece in Athens before coming to M.I.T.)

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"Emerging Technologies: Taking on Tomorrow"

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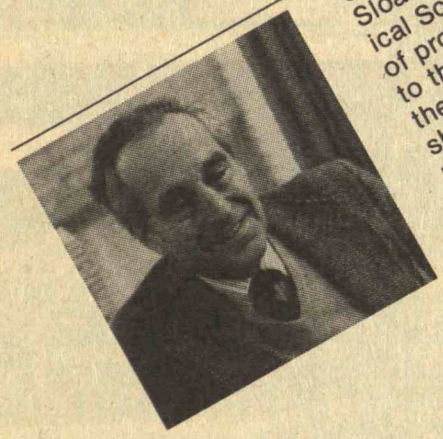
July 15-20

The MIT Alumni Summer College is a five-day academic seminar for alumni and their families. There are special programs for children and social and recreational activities for all members of the family.



Join Ithiel de Sola Pool, Sloan, Professor of Political Science, and a team of professors looking into the future at some of the forces that will shape business, government, and society in the next decade.

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100 Alumni and 14 Faculty Join to Compare Science and Decisionmaking in France and the U.S.

"M.I.T. Day in Europe" was his triumphant phrase as Guy J. Viellet, S.M. '50, president of the M.I.T. Club of Paris, introduced President Jerome B. Wiesner to an audience of more than 100 M.I.T. alumni at the UNESCO world headquarters building in Paris on February 3. It was one of the largest European M.I.T. gatherings in history, with alumni from as far as Scotland and Finland in Paris for an all-day program on "Science and Decision" climaxed by dinner and the evening performance at the famous Lido.

The theme was drawn from a two-day Paris colloquium of the same title — a joint undertaking of M.I.T. and the French Centre National de la Recherche Scientifique to study scientific progress and policymaking — held on February 1 and 2. At least a score of members of the faculty and staff had attended the colloqium, and 14 of them — perhaps the largest faculty delegation ever to participate in a overseas alumni meeting — spoke on February 3. The late Bernard P. Gregory, Ph.D. '50, who was director general of C.N.R.S. from 1973 to 1976, had been instrumental (with Walter A. Rosenblith, provost of M.I.T., and several members of the M.I.T. Club of Paris) in designing the colloquium, and it was named in Dr. Gregory's honor.

As a keynoter at the colloquium, President Jerome B. Wiesner said that "a technologically-based society is — and must be — a dynamic system in a continuing state of change and evolution, always learning by experimenting with new technologies, new organizational forms, new relationships among its organizations and its citizens." Even as we become more sensitive to the consequences of technology, he said, we must learn how to "retain the benefits of an open, innovative society.

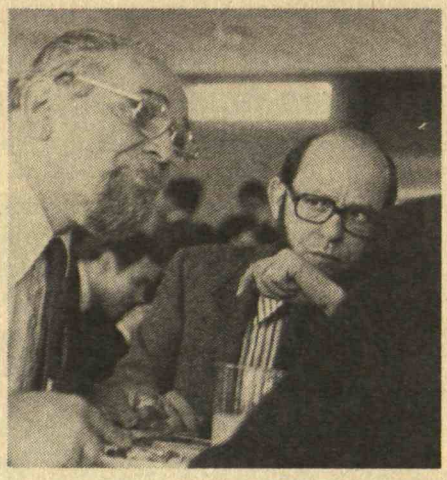
"The growing difficulty of decisionmaking as societies become more complex and at the same time more democratic [is] the basic challenge . . . [to the] health and viability of the democratic industrial states," Dr. Wiesner said.

The Gregory Colloquium had been preceded by two years of cooperative studies by French and U.S. scientists of how industry and government officials, scientists, and the public affect decisionmaking in the development of technology. There were case studies of how telephone and railroad systems — for example — developed differently in the U.S. and in France despite their common technological base; of how different political settings affected French and U.S. urban systems after World War II; and of energy and health systems in the two countries.

Most of the speakers at "M.I.T. Day in Europe" brought to the alumni the same messages they had brought to the Gregory Colloquium of the previous days. Robert C. Seamans, Jr., Sc.D. '51, dean of engineering, urged government support for synthetic fuel development; Leon R. Glicksman, '59,

Frank Press, White House science adviser on leave from the Department of Earth and Planetary Sciences at M.I.T., brings a case history of the interface between science and policy to "M.I.T. Day in Europe" in Paris in February: What is the effect of government policy on the flow of innovations in science and engineering? The answer to that question is "the most important issue in my office" this year, Professor Press told his Paris audience. On the platform behind him, waiting to participate in a panel on the science-policymaking interface, are (left to right) Professors Ithiel D. Pool, Kenneth Keniston, Elting E. Morison, Walter A. Rosenblith, Eugene B. Skolnikoff, '49, and Leon Trilling.

One of the largest gatherings in history of M.I.T. alumni in Europe began on February 3 with Guy J. Viellet (right), S.M. '50, welcoming guests to the UNESCO world headquarters as President of the M.I.T. Club of Paris. For the next eight hours the 14 members of the faculty on hand for "M.I.T. Day in Europe" were busily engaged by more than 100 alumni; in the pictures (clockwise) are Robert C. Seamans, Sc.D. '51, Dean of Engineering; Walter A. Rosenblith, Provost; and Jerome B. Wiesner, President.



of the Energy Laboratory, reported on comparative studies of "district heating" systems — central steam or hot water plants which supply heat to many surrounding homes — widely used in Scandanavia and the U.S.S.R.; and Paul L. Joskow, professor of economics, described U.S. policy options for future energy resources.

Responses in the U.S. and France to scientific information about the health effects of tobacco smoking have been the same, said Professor Jeffrey E. Harris of the Department of Economics. Both countries mounted anti-smoking campaigns with similar results: smoking has declined among men and remained nearly constant among women, and the campaigns had little if any effect on the way young people started smoking. In contrast, tobacco companies have responded by decreasing the harmful constituents in their products, said Dr. Harris.

Summarizing the Gregory Colloquium, Professor Eugene B. Skolnikoff, '49, told the alumni that no one seemed satisfied with "existing methods for integrating science and decisionmaking. . . . There is a desperate need," he said, "to focus increasingly on the process by which society deals with questions that involve more and more technology."

Alumni in the audience, hearing more about policy and less about technology than they expected, urged M.I.T.'s traditional role in rigorous scientific and engineering training. The responses came from President Wiesner and Professor Kenneth Keniston of the School of Humanities and Social Science:

☐ President Wiesner: "It is not our goal to create a new kind of professional trained to be both scientist and manager. [The problem is] to give students several cognitive styles, several ways of thinking about society, science, and politics."

☐ Professor Keniston: There is a need for "a double literacy" in M.I.T. students — the traditional disciplines which rest on mathematics and physics as well as "a disciplined understanding of modern society and of man." — *J.M.*

C. W. Brenner

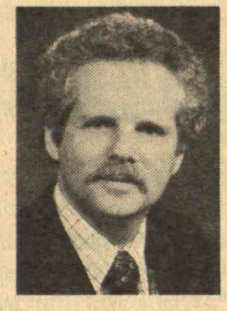
S. J. Goldstein

J. F. Moore

E. V. Wade

P. P. Shepherd

J. K. Littwitz



W. A. Bayer

N. R. Klivans

Selection Committee Choices: Brenner, Goldstein, Moore, Wade, and Six Others

Claude W. Brenner, '47, will lead the Alumni Association as its president in 1979–80. He's the choice of the 1979 Selection Committee, of which Philip H. Peters, '37, is Chairman.

Three alumni have been nominated to serve for five years as members of the M.I.T. Corporation: S. James Goldstein, '46, Joe F. Moore, '52, and Emily Vanderbilt Wade, '45.

Since 1976 Mr. Brenner has been vice president — operations of Northern Energy Corp., Cambridge, where he is in charge of all internal operations of the Northeast Solar Energy Center, dedicated to accelerating the commercial development of solar energy in New England; he had been associate director of New England's proposal for the Solar Energy Research Institute. Since receiving his M.I.T. degrees in aeronautical engineering (S.M. 1948), Mr. Brenner has held a variety of responsibilities in the field of marketing innovative technology; at the same time he's had increasing responsibilities in alumni affairs, concentrating especially on new opportunities for alumni to interact with and serve the Institute.

Mr. Goldstein is founder and managing partner of James Goldstein and Partners, architects, engineers, and planners of Millburn, N.J., specializing in major research, office, and library facilities for universities, corporations, and government agencies. As an alumnus Mr. Goldstein has been active for 15 years in the M.I.T. Alumni Center of New York, and he has been a member of Corporation visiting committees to the Libraries and the Department of Architecture as well as of the Alumni Association's Board of Directors.

Mr. Moore will conclude his term as president of the Association in July 1979, when he's due to join the Corporation as an alumni member. He is a founder and now president of Bonner and Moore, Inc., a leading consultant to the petroleum and petrochemical industries on refining and processing. Mr. Moore "came up through the ranks" to his leadership of the Association in 1978–79, having been active in the south Texas area since 1964 and in national affairs since 1970.

Ms. Wade will join the Corporation after serving one year of a two-year term on the Association's board of directors; she's a leader of the Boston Zoological Society (of which she was Chairman until last year), chairman of the State-Industry Advisory Council of M.I.T.'s Sea Grant Program, director of the Massachusetts Audubon Society, and a member of the visiting committee to Boston University's Biology Department.

Other choices for Alumni Association leadership beginning in July, 1979, by the Selection Committee include:

☐ Paul P. Shepherd, '53, to be vice president (two years). After major responsibilities

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Harvard Law School '58 L.L.B.

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One Beacon Street, Boston, Mass. 02108

M. P. Slocum

T. J. Lamphier

O. E. Kirchner

for Cabot, Cabot and Forbes on the West Coast, Mr. Shepherd founded his own firm in the field of commercial and industrial real estate in Daly City, Calif., in 1977. He's been a leader of alumni affairs in northern California and a member of the Corporation and of its visiting committees in economics and civil engineering.

☐ James K. Littwitz, '42, to be Vice President (two years). Mr. Littwitz, whose degree is in chemistry, is assistant manager of paper manufacturing for Eastman Kodak Co. He's been active in M.I.T. affairs in Rochester, N.Y., since the 1960s and began responsibilities on a national level in the 1970s.

☐ William A. Bayer, '58, to be director (two years) representing district 3. A specialist in precast concrete technology, Mr. Bayer is a founding partner of Kahn and Bayer, consulting engineers, of Manchester, Conn. He's been a leader of the M.I.T. Club of Hartford and will conclude a four-year term on the Alumni Fund Board in July.

☐ Norman R. Klivans, '40, to be director (two years) representing district 6. Mr. Klivans was for many years associated with Clevite Corp. (now Gould, Inc.), most recently as group vice president–electronics; he is now vice president of Western Reserve Associates, management consultants. He's held most of the leadership assignments for M.I.T. in the Cleveland area in various years since 1971.

☐ Marianna Polonsky Slocum, '55, to be director (two years) representing district 7. Ms. Slocum is acting scientific adviser to the U.S. Department of Energy, and since completing work at the Institute she has developed a specialty in national and international energy resources and associated planning, economic, strategic, and policy issues. She maintains an active role with the M.I.T. Club of Washington, D.C., and with the Educational Council in the nation's capital.

☐ Thomas J. Lamphier, '49, to be director (two years) representing district 8. Mr. Lamphier joined the Great Northern Railway upon graduating from M.I.T., and he's now risen to become president of the Transportation Division of Burlington Northern, Inc.; he's also president of Western Fruit Express Co. and executive vice president of the Colorado and Southern and Fort Worth and Denver Railways, both Burlington Northern subsidiaries. And he's a director of Amtrak, the National Railroad Passenger Corp.

☐ Otto E. Kirchner, Jr., '49, to be director (two years) representing district 9. Mr. Kirchner helped found Resources Conservation Co. in 1969 to specialize in desalination and mineral recovery from brackish and industrial wastewaters, and he is now president of the company's international subsidiary focusing on water treatment problems in the Mideast; he's also a director of the National Water Supply Improvement Association. Mr. Kirchner was a major force in the M.I.T. Club of Puget Sound in the 1960s and more recently has been active in alumni affairs at the national level.

J. L. Bidigare

Regional Coordinator for the Mid-Atlantic

James L. Bidigare, Jr., '78, now has a desk at the M.I.T. Alumni Center of New York, where he's the Alumni Association's regional coordinator for the Mid-Atlantic states.

His responsibilities include support for many areas of alumni relations and activities — with emphasis on Alumni Fund programs and special projects.

Just before he graduated last June, Mr. Bidigare was named president of his class for the five years ending in June, 1983. As an undergraduate he was active in his fraternity, Sigma Chi, and was secretary and chairman of community relations for the Interfraternity Conference; he was also captain of the varsity lightweight crew.

Lucille Jones Goes to China — She's a "Natural" for the First U.S.-P.R.C. Exchange of Scholars

Lucille M. Jones studied Chinese language and literature and physics for her Bachelor's degree (1976) at Brown University. Then she came to the Department of Earth and Planetary Sciences for graduate work.

Her interest in Chinese was no accident: two of her uncles have been "China experts" for the U.S. government, and she lived in Taiwan with one of them for the year when she graduated from the Taipei American High School. Then she went back for her junior year at the Stanford Center in Taipei, studying Chinese in a program administered by Stanford University. Her grandparents lived in China for 40 years as Methodist missionaries.

Now she's headed back to the Far East once more — this time to Mainland China (her first time there) as a member of the first small group of 12 American students and scientists chosen to inaugurate the new U.S.-China scientific exchange.

Ms. Jones will work for several months, until sometime in the spring, in earthquake mechanics and prediction — two fields in which the Chinese have made notable achievements — at the Institute of Geophysics in Peking.

Science and Chinese have been Ms. Jones's two passions "all along," she says. So her interest in the fellowship program for U.S.-China exchanges was obvious: "I'm really lucky my interests fit together so well when this program came along."

Was she surprised that it all happened to her so quickly? Recognition of the People's Republic was "the obvious thing to do," she says. But, yes, "I was just a little surprised it happened so soon."

Chinese Scholars at M.I.T.

While M.I.T. was sending its first student to China under the new exchange program *(see left)*, it was preparing to host four Chinese experts as visiting scholars in Cambridge.

Yueh Tseng-yuan, lecturer in the Department of Geophysics at Peking University, and Huang Yung-nein, lecturer in that University's Department of Mathematics and Mechanics, are spending the entire spring term in Cambridge, Mr. Huang working in fluid mechanics and Mr. Yueh in plasma dynamics. They'll be joined in April by two Chinese computer scientists, Kung Jung-shu and Li Yen-ta, who will work in the Department of Electrical Engineering and Computer Science.

Professors C. C. Lin of the Department of Mathematics and Samuel C. C. Ting of the Department of Physics had key roles in arranging for these visitors, who come to the U.S. as a result of the agreement reached last year between the U.S. and P.R.C. The exchanges were proposed to provide "mutual benefit to both countries," and it was agreed that "each side would expeditiously grant visas for such exchanges," according to a memorandum cited by Professor Lin.

Individuals Noteworthy

Honors and Awards at M.I.T.

Ten members of the M.I.T. community are among 1979 Fellows designated by the Institute of Electrical and Electronic Engineers: **Paul H. Carr,** '57; Professor **Mildred S. Dresselhaus,** Director of the Center for Materials Science and Engineering; Professor **Ira Dyer,** '49, Head of the Department of Ocean Engineering; **Charles Freed,** S.M. '54; **Henry P. Hall,** '51, of Genrad Co.; Professor **Robert W. Mann,** '50 (mechanical engineering); **Robert A. Purcel,** '50, Raytheon Co.; **Alan J. Simmons,** S.M. '48, Lincoln Laboratory; Professor **David H. Staelin,** '60 (electrical engineering and computer science); and Professor **Laurence R. Young,** '57 (aeronautics and astronautics).

Peter H. Richardson, '48, is a member of the Council on Access Services of the College Entrance Examination Board. . . . **Joel Orlen,** executive officer in the Office of the Provost, is secretary of the Massachusetts Technology Development Corp. . . . Professor **Nazli Choucri** (political science) is coauthor (with Thomas W. Robinson of the National War College) of *Forecasting in International Relations: Theory, Method, Problems, and Prospects.* . . . Professor **Charles Weiner,** Director of the Oral History Program, is a member of the Humanities Advisory Board to radio station WGBH, Boston.

To Professor **Samuel C. C. Ting** (physics), an honorary doctor of science

J. W. Forrester

C. E. Kelley

degree from his alma mater, the University of Michigan . . . to Professor **Lawrence B. Evans** (chemical engineering), corresponding membership in the National Academy of Engineering of Mexico . . . to Professor **Marcus Karel,** Ph.D. '60, associate head of the Department of Nutrition and Food Science, membership in the Food Engineering Hall of Fame . . . to Professor **David Epstein,** conductor of the M.I.T. Symphony Orchestra, an ASCAP award from the American Society of Composers, Authors, and Publishers for his "support of the growth and development of our nation's musical future" . . . to Professor **Christopher T. Walsh** (Chemistry and biology), the 1979 Eli Lilly award in biological chemistry of the American Chemical Society . . . to Professor **Jay W. Forrester,** S.M. '45 (management), membership in the National Inventors Hall of Fame for his invention of the core memory for digital computers . . . to Professor **Ronald S. Newbower** (Harvard-M.I.T. Division of Health Sciences and Technology), the Arnold O. Beckman award of the Instrument Society of America for electronic thermometer developments . . . to Professor **Wesley L. Harris,** Director of the Office of Minority Education and **Wade M. Kornegay** of the Radar Signature Studies Group at Lincoln Laboratory, awards as "Black Achievers" from the Greater Boston Y.M.C.A. . . . to Professor **Richard R. Schrock** (chemistry), a Dreyfus Teacher-Scholar Grant from the Camille and Henry Dreyfus Foundation.

M.I.T. Changes

Janet K. Anderson, administrative assistant in the Industrial Liaison Program, to assistant director for administration of the program . . . **Vera J. Ballard,** formerly counselor and manpower planner in Rhode Island, to administrator supporting development and training programs in the Office of Personnel Development . . . **Clare K. Chapman,** formerly director of research at the Federation for Railway Progress and more recently assistant to the chairman of Allegheny Corp., to special assistant in resource development as researcher/writer . . . **Charles L. Ellis,** formerly with the M.I.T. Audit Division, to administrative officer of the Center for International Studies . . . **E. Jane Griffin,** administrative assistant to the treasurer, to additional responsibilities as administrator of life income plans . . . **Clyde E. Kelley,** formerly senior project engineer at Exxon Research and Engineering Co., to assistant director of the M.I.T. Associates Program . . . **Winifred T. McDonough** promoted to associate recording secretary in the Treasurer's Office . . . **Shirley M. Picardi,** Ph.D. '76, to assistant director of the Industrial Liaison Office Program . . . **Frederick J. Quivey,** formerly manager of financial information and planning at the Sloan School, to assistant dean of engineering for administration.

Kudos: Award, Honors, Citations

Austin Whillier, Sc.D. '53, director of the Environmental Laboratories of the South African Chamber of Mines' Research Organization, is recipient of the national Award of the Associated Scientific and Technical Societies of South Africa for his contribution to the control of the thermal environment in deep-level mining. . . . **John W. Reed,** Ph. D. '72, is winner of the T. R. Higgins Lectureship Award of the American Institute of Steel Construction for the paper on "Human Response to Wind-Induced Motion of Buildings" *(A.S.C.E. Structural Engineering Journal,* July, 1973); co-authors were Professors **Robert J. Hansen,** Sc.D. '48, and **Erik H. Vanmarcke,** Ph.D. '70 (civil engineering).

To **Leslie C. Dirks,** '58, deputy director for science and technology of the Central Intelligence Agency, the National Security Medal (the presentation was made by President Jimmy Carter, but reporters and photographers were not invited and the citation for the award was classified).

Donald S. Tucker, 1885–1979

Donald S. Tucker, who retired in 1950 after 31 years as a member of the Department of Economics, died in Concord, Mass., on February 14. He was 94.

Professor Tucker was graduated from Colorado College in 1906 and received his master's degree in economics from Williams College in 1912. He came to M.I.T. in 1919

while completing requirements for his doctorate at Columbia, which he received in 1922. In addition to his M.I.T. faculty assignment, Professor Tucker taught economics at Wellesley; and after reaching retirement age he continued as senior lecturer at M.I.T. until 1955.

Willard F. Rockwell, 1888–1978

Willard F. Rockwell, '08, who rose from a $10-a-week job as chemical plant superintendent to become "one of America's foremost industrialists and innovators in industrial technology," died on October 23, 1978, in Pittsburgh, after a five-year illness. He was 90.

Mr. Rockwell studied electrical engineering at M.I.T., and his career in the management of technology began when he became factory manager of Torbeson Axle Co. in 1915. By 1925 he had begun acquiring, revitalizing and collecting small firms into the Rockwell Manufacturing Co. which finally became part of North American Rockwell and, in 1973, Rockwell International Corp. The quotation is from a citation by President Dwight D. Eisenhower.

Ely Mencher, 1914–1978

Ely Mencher, Ph.D. '38, chairman of the Department of Earth and Planetary Sciences at City College of the City University of New York, died in White Plains, N.Y., on December 11. He was 64.

Professor Mencher had taught geology at M.I.T. as a graduate student from 1935 to 1938 and then as a member of the faculty from 1952 to 1968; he left to join City College as department head for four years in 1968, and he was recalled to that post in 1977. During the 1940s he had served as field and research geologist for Socony Mobil Oil Co. in Venezuela.

Edwin S. Burdell, 1898–1978

Edwin S. Burdell, '20, who established and became the first dean of M.I.T.'s School of Humanities and Social Sciences and went on to become director and later president of the Cooper Union in New York, died on August 30, 1978, in Maitland, Fla., following a

With the Alumnae

It's no news that alumnae are a small portion of the total M.I.T. alumni body. This column consolidates notes on M.I.T. women graduates and news of interest to them.

Dr. **Susan L. Kannenberg,** '61, recently left Boston Edison for the Northeast Solar Energy Center in Cambridge, where she is now a Senior Systems Analyst, working on solar resource assessment and solar systems analysis. . . . Dr. **Paula J. M. Jacobs,** '66, is also now working in Cambridge, as a Group Leader/Senior Chemist at Clinical Assays. Paula reports that she loves her work in process development and "troubleshooting" at Clinical Assays, which produces radioimmunoassay kits to detect hormones in blood. She has one child, now aged 3.

Laura B. Clausen, M.C.P. '66, is now Assistant Secretary for Higher Education in the Executive Office of Educational Affairs (a Cabinet office) in Boston. Laura worked with the Secretary, Charles Johnson, when she was a consultant for Arthur D. Little in 1967–68, and gained much experience leading to her present job while serving as Chairman of the Board of Higher Education in Boston, beginning in 1975.

Dr. **Susan Grant,** '67, writes that she is "loving our new house in Sudbury [Mass.]" (she is married to Dick Grant, '65) and enjoying her work as Staff Psychiatrist for the Charles River Counseling Center in Newton. . . . Dr. **Louise H. Foley,** Ph.D. '70, works full-time as a Research Scientist at Hoffman-LaRoche Inc., Nutley, N.J., and also holds a half-time appointment as Assistant Professor of Chemistry at Fordham University, the Bronx, N.Y. . . . **Sandra Gay Yulke,** '74, is "very involved" with her work writing proposals for environmental science/engineering/planning studies at Camp Dresser and McKee, Boston, for both industrial and municipal clients and federal and other agencies. Sandy has begun work toward the M.S. degree at Northeastern University in environmental engineering.

Dr. **Christina Jansen,** '63, and **Lita Nelsen,** '64, offered the I.A.P. course "Tactics for Women in Industry: A Guerilla Guide to the Pinstriped World" this January for the fourth consecutive year. The course, sponsored by the Association of M.I.T. Alumnae, is designed to encourage women students to investigate the wide variety of industrial situations. Chris and Lita guided their 30 students (ages ranged from 20 to 50) through interview training and other aspects of entering jobs in industry. Next year, the pair is thinking of changing the focus of the course to a characterization of industry, and discussing different management styles, philosophies, environments, and possible career growth patterns for women in industry. Both welcome your suggestions for next year; write to either Chris or Lita at Millipore Corporation, Ashby Road, Bedford, Mass. 01730.

Just over three years ago, **Lucille Roseman,** S.M. '72, joined three partners to found Xenergy, Inc., an energy consulting firm in Lexington, Mass. Lucille's specialization at the Sloan School was finance, and she is now the fiscal officer of Xenergy, which does "energy audits" of potential energy-use reductions in facilities ranging from factories to churches and greenhouses. Xenergy presents its government and commercial clients with an assessment of the energy savings as a monetary investment, where Lucille's expertise plays a large part. Lucille reports that Xenergy now has a very busy staff of 25, which also produces workbooks for energy conservation in any given industry.

A few notes from '78s: **Pamela Hall,** '78, is now working on the metabolism of collagen in pulmonary fibrosis at Children's Hospital, in the Orthopedics Research Department. . . . **Susan M. Schneider,** M.Arch. '78, is now Susan Schneider-Criezis (she married fellow M.Arch. Demetrios Criezis '77) and aims to be a licensed architect by summer 1979. She is presently working for an architectural firm in Chicago. **Hazel M. Wong,** '78, also an architect, now works in the design department of Parkin Partnership Architects Planners in Toronto.

Most of the entries in this column come to me courtesy of A.M.I.T.A., which remains the central organization through which M.I.T. women graduates relate to the Institute. A.M.I.T.A.'s greatest concern continues to be enhancing the position of women in the Institute, and welcomes your support of their activities by your attendance at any A.M.I.T.A. meetings, or by your help in planning or directing programs. Upcoming A.M.I.T.A. activities include the annual brunch with senior women students in March, at which the opening of suggestions for the Student Award (a monetary prize recognizing solely academic excellence in women students) is announced. In April, A.M.I.T.A. will hold its (now traditional) meeting at the M.I.T. Historical Collections, and the Annual Meeting (with election of new officers for 1979-80) will be held in May at Endicott House, M.I.T.'s lovely estate in Dedham. For more information, write to A.M.I.T.A. care of the Alumni Association. I look forward to hearing news of all alumnae for this column. If you have recently changed your job or lifestyle, begun or finished with school, or would simply like word of your whereabouts made known to old friends, write to me. — **Elizabeth A. Greene,** The M.I.T. Alumni Center, Room 10–119, Cambridge, Mass. 02139

long illness. He was 80.

Dr. Burdell earned national and international recognition for his work as educator and sociologist and particularly for his efforts to include the humanities in the technical curriculum of engineering. To his undergraduate degree in management from M.I.T. Dr. Burdell added graduate work leading to master's and doctorate degrees from Ohio State University as well as studies at Harvard Business School. He taught English and history at M.I.T. briefly in the 1920s and then returned to teach economics from 1934 to 1938 and to organize the new school which he headed for one year before becoming operating director of the Cooper Union.

While leading that institution toward what he called "scientific humanism," Dr. Burdell continued his association with the Institute and its alumni. After his retirement in 1960, Dr. Burdell undertook to establish a Middle East Technical University in Ankara, Turkey, where he worked for two years, and then for three years he was dean of Rollins College, Winter Park, Fla.

Deceased

Robert K. Taylor, '07; September, 1975; 2725 Marion Ave., Bronx, N.Y.
Willard F. Rockwell, '08; October 16, 1978; Rockwell Intl. Corp., 400 N. Lexington Ave., Pittsburgh, Penn.
John R. Reyburn, '08; December 12, 1978; Longwood Ave., P.O. Box 216, Hyannis Port, Mass.
Maj. Gen. Kenneth T. Blood, '09; January 29, 1979; Suburban Nursing Home, 1 Great Rd., Acton, Mass.
Lawrence T. Cummings, '12; January 4, 1979; Rt. 4, Connersville, Ind.
Bates Torrey, Jr., '12; December 17, 1978; 746 Stinard Ave., Syracuse, N.Y.
George W. Bakeman, '13; December 4, 1978; The Oaks, Hanover, Va.
Bion L. Pierce, '13; December 6, 1978; Mill St., Assonet, Mass.
Edgar W. Taft, '13; August 2, 1978; c/o Cen. Bk./Tr.; P.O. Box 14728, Ft. Lauderdale, Fla.
Charles E. Trull, '13; September 16, 1978; 38 Armistice Blvd., Pawtucket, R.I.
Allan G. Waite, '13; January 5, 1979; The Newfield House, Plymouth, Mass.
Frederick A. Dale, '14; January, 1978; 1617 Hendersonville Rd., Asheville, N.C.
Hubert S. James, '15; December 14, 1978; 41506 Fulton Ave., Hemet, Calif.
Lewis M. Dow, '16; November 19, 1978; Masonic Home of Florida, 125 32nd Ave. N.E., St. Petersburg, Fla.
Thomas Meloy, '17; January 4, 1979; Shoreham West, Apt. L–105, 2500 Calvert St. N.W., Washington, D.C.
Walter C. Wilson, '18; September 23, 1978; 52 Clark Rd., Lowell, Mass.
Freeman H. Horton, '19; November 24, 1978; P.O. Box 958, Bradenton, Fla.
Paul D. Sheeline, '19; January 12, 1979; 17 Emerson Pl., Boston, Mass.
Malcolm S. Howe, '20; January 5, 1979; P.O. Box 32, New Gloucester, Maine
Arthur Winebaum, '20; January 24, 1979; 52 Loveland Rd., Brookline, Mass.
Lawrence W. Conant, '21; January 16, 1979; Greenbriar, Apt. A-113, Washington, D.C.
Charles W. Maloney, '21; December 30, 1978; 9 Windsor Rd., Cohasset, Mass.
Samuel E. Moreton, Jr., '21; November 16, 1978; Box 537, Brookhaven, Miss.
Richard H. Morris, '21; July 30, 1978; 2416 Third St., Santa Monica, Calif.
A. Royal Wood, '21; January 10, 1979; 15 Charlton Hill, Hamden, Conn.
William E. Cooper, '22; July 4, 1977; 10 Groesbeck Pl., Delmar, N.Y.
Rev. Theodore S. Wray, '22; September 7, 1978; 443 Northcroft Rd., Springfield, Penn.
Forrest F. Lange, '23; January 11, 1979; 1196 Woodbury Ave., Porthsmouth, N.H.
Herman Swett, '23; December 6, 1978; 364 Cliff Dr., Pasadena, Calif.
John O. Holden, '24; October 6, 1978; 15 Colby Rd., Braintree, Mass.
Capt. Chester V. Jones, '24; December 25, 1977; 3855 S.W. Condor Ave., Portland, Ore.
Frank W. Warren, '24; November 26, 1978; 456 South St., New Providence, N.J.
John T. Dixon, '26; January 7, 1979; 12 Marion Ave., Short Hills, N.J.
Lawson V. Peakes, '26; September 21, 1978; 322 Brookwood Ave., Rome, Ga.
Constantine Bary, '27; December 17, 1978; 5215 Lodge Creek Dr., Greenwood Forest, Houston, Tex.
Richard G. Buzby, '28; October 17, 1978; 2009 Oakfield Rd., Grand Island, N.Y.
William J. Kirk, '28; January 10, 1979; Box 383, North Falmouth, Mass.
Irving H. Small, '28; October 17, 1978; 136 Poplar Ave., West Springfield, Mass.
John A. Ginley, '30; January 4, 1979; 11 N. Lewis Rd., East Walpole, Mass.
James M. Pickell, Jr., '30; November 18, 1978; 167 Broad Ave. S., Naples, Fla.
Mark T. Purcell, '30; October 6, 1978; 3210 Nottingham Way, Madison, Wis.
Nathaniel P. Rand, '30; March 7, 1978; P.O. Box 245, Newark, Del.
Frederick W. Turnbull, '30; November 20, 1978; 11109 Ardwick Dr., Rockville, Md.
Roger P. Brown, '31; February 28, 1978; 2802 Copper Ave., El Paso, Tex.
Raymond Donway, '31; December 11, 1978; 97 Birchwood Dr., Holden, Mass.
Donald L. Herbert, '31; September 12, 1978; Rt. 7, Box 379, Mountain Home, Ark.
Lester B. MacFarland, '31; December 31, 1978; 425 Bellini, Nokomis, Fla.
Robert H. Morris, '32; June, 1971
E. Leslie Huse, '35; October 25, 1978; 15 Brook Dr., Morris Plains, N.J.
Albert G. Emerson, Jr., '36; November 10, 1978; c/o Lewis, 191 Broadway N., Haverhill, Mass.
Capt. Hugh S. Knerr, '36; August 23, 1978; 9–24th Ave., Box 335, Isle Of Palms, S.C.
John G. Goldfuss, '37; July 19, 1978; 166 Tullamore Rd., Garden City, N.Y.
Allen V. Hazeltine, '37; August 6, 1978; 524 Mulberry Ln., Haverford, Penn.
Dr. Wilbur J. Wald, '38; October 11, 1978; c/o Maurice B. Van Ackeren, 5225 Troost Ave., Kansas City, Mo.
Herbert G. Dorsey, '39; August 8, 1977
Robert Iredell III, '39; December 10, 1978; 3769 Bay Path Dr., Akron, Ohio
Victor K. Wagner, Jr., '41; August 14, 1978; 3324 S.E. Fairway E., Stuart, Fla.
Arthur G. Walsh, '41; December 15, 1978; 117 E. Main St., Barrington, Ill.
Richard Fay, '42; October 15, 1978; 339 Nahant Rd., Nahant, Mass.
Alfred B. Rose, Jr., '46; November 6, 1977; 214 Riverside Dr., Toronto, Ont., Canada
John A. Ballard, Jr., '49; August, 1978; Apt. B-111, Key West Towers, Key West, Fla.
George D. Latimer, '49; February, 1978; 4291 Stoneleigh, Bloomfield Hills, Mich.
Thomas Cerwonka, '50; November 28, 1978; 172 Main St., Kingston, N.Y.
John R. Keefe, Jr., '50; June 2, 1977; 4 Norfolk Rd., Winchester, Mass.
Dr. Henry J. Albert, '52; September 19, 1978; Maple Dr., Colts Neck, N.J.
Dr. Edward F. Turner, Jr., '52; September 30, 1978; 23 Sellers Ave., Lexington, Va.
Robert W. Wagner, '54; January 23, 1979; 12 Garrison Rd., Belmont, Mass.
Earl P. Ford, '55; November 27, 1978; 17 N. Penns Ave., Belleville, Ill.
George H. Saunders, '63; September 25, 1978; 32200 Valor Pl., Palos Verdes Pen., Calif.
Ralph H. James, '64; February, 1978; 70 Shalimar Pl., 4100 Salish Dr., Vancouver, B.C., Canada
Robert C. Knowles, '73; January 8, 1979; 1313 Bruton Ln., Virginia Beach, Va.

03

Well, my cheerful classmates, we are approaching our hundred milestone in age. Your active secretary walks around with two canes to avoid stumbling on sidewalks. However, I still lack rheumatism and credit this to my simple daily living — plenty of rest and old-fashioned meals without any liquor to conflict with normal heart stimulation.

So, loving pals, I sympathize with any one of you in discomfort by some ailment; yet our common sense can secure our desired esprit.

Our classmate **Andrey Potter**, recently distinguished by Purdue University for his 50 years as head of the electrical engineering department, is now residing at Milner Health Care Center in Rossville for closer medical care. His loving daughter, Helen visits him almost every day with nearby associates.

Our happy birthday celebration extolls **Ichabod Atwood** (February 28, 1882), **Frederick Lord** (February 5, 1878), and **Frederic A. Olmsted** (February 27, 1882). — **John J. A. Nolan**, Secretary/Treasurer, 417 Dorsey Way, Louisville, Ky. 40223

08

Alumni Day 1978, the 70th anniversary of our graduation, passed with very little notice from the surviving members of the class. **Franklin Towle** and your secretary and his wife were the only representatives of the Class of 1908 at the Alumni Luncheon. **Joe Wattles** had just given up the job of secretary. He is now at the Norwood Nursing and Retirement home, 767 Washington St., Norwood, Mass. 02062.

I happen to be the first one to have earned a doctor of engineering degree from M.I.T., and I was astonished to learn that about 900 of these degrees have now been awarded. Within a year or two, it is expected that the number will exceed 1,000. The fact that so many young students find it worthwhile to devote the added years to advanced study is good evidence that this degree is valuable.

It is my duty to announce the recent death of two of our classmates: **Willard Rockwell** died October 11, 1978, at the age of 90 after a long and very productive career leading to the formation of Rockwell International Corp. He is survived by his son Willard Rockwell, Jr. **John R. Reyburn** died December 12, 1978, at the age of 92 from complications resulting from a broken hip. His career was primarily with Stone and Webster and with American Chain and Cable Co. He was a prolific inventor, with more than 50 patents. He is survived by his wife, who lives in Hyannis Port, a son Nathaniel R. Reyburn of Erie, Penn., eight grandchildren and eight great-grandchildren.

I ask all surviving members of the Class of 1908 to send me accounts of all items of interest which can be the basis of further notes in *Technology Review*. — **Harold S. Osborne**, Secretary, 375 Highland Ave., Upper Montclair, N.J. 07043

Larry Cummings, '12

12

Johnathan Noyes, class president, sends the following news: "Our class secretary **Larry Cummings** died on January 3, 1979, in Connersville, Ind., at age 89." Mr. Cummings, a prominent business man and civic leader, received his bachelor's degree from M.I.T. in electrical engineering. In 1926 he joined McQuay-Norris Manufacturing Co., retiring as general manager and vice president in 1954. During World War I he was with Miller, Franklin, Basset and Co., industrial engineers and accountants of New York City, and thereafter was employed by consultant and engineering firms in Detroit and Muskegon, Mich., and Elkhart, Ind.

His civic involvements included membership in A.S.M.E., Kiwanis Club, Rotary Club, the First United Presbyterian Church in Connersville, Chamber of Commerce, Y.M.C.A, to name only a few. Mr. Noyes sends the sympathy of the class to his widow, Mrs. Julie Cummings. Mrs. Cummings writes: "He much enjoyed being class secretary and kept meticulous records." A memorial service was held at the Presbyterian church on January 6, and contributions were made to Boy Scouts of America and the American Heart Association.

Mr. **Phillip Dalrymple**, 59 Boulder Rd., Wellesley, Mass. 02181, (617) 235-2231, will carry on as class secretary.

From his granddaughter, Daphne Gurney, we received the following: **"Charles Donald MacCormack**, aged 94, died on November 9, 1978, in Willow Grove, Penn. He attended the University of New Brunswick, Fredericton, in 1903 and received the Brydone-Jack Scholarship in 1906 and the Ketchum Medal in 1907. He received his bachelor's degree in civil engineering from U.N.B. in 1907 (graduating with honors) and a second degree (also in civil engineering) from M.I.T.

A man of unbounding energy, he held engineering positions with the Canadian Pacific Railway, Hill Leonard Co. of Toronto, and the Hydro-Electric Co. of Ontario. In 1916 he accepted a position with the Boston and Maine Railroad and later relocated to Medford, Mass., where he lived for the next 45 years. Other companies claiming his talents, even after retirement (on a consulting basis), included Eastern Gas and Fuel Associates and the Carpenter-Patterson Engineering Co.

The beneficiary of a 19th century classical education, Charles was truly a Renaissance man. He maintained a lively and enthusiatic interest in all branches of knowledge, including classical and modern literature, astronomy, and music. He was an active member of Grace Church and an excellent gardener.

He is survived by a son, Charles Donald MacCormack, Jr., of Watsonville, Calif.; and three daughters: Georgie A. Gurney of Richmond, Va., H. Miriam Barbour of Abington, Pa., and V. Elizabeth Monroe of Greenville., Pa., as well as 11 grandchildren. — *S.K.*

13

Your scribe is escaping to southern California for a few weeks, but after the severe snow storms over most of the country this winter, can spring be far behind?

Ken Blake sent us a beautiful photograph, which I presume he took, of a snow-covered mountain. He also writes: "My sincere sympathy on Phil's passing, and appreciation of your continued work for '13." . . . **Frederick W. Lane** sent "Christmas Greetings, Rosalind." . . . A note from Arny and **Larry Hart** reads, "No news except we are doing as usual day by day and keeping busy — our very best in 1979." . . . Also received a card from Maurine and **Allen Brewer** with this note: "Let us add our appreciation for the efforts you and Phil put forth on behalf of 1913. I've already written you about our activities. I find it greatly relaxing just to look out on the Indian River and think of words for my poems. I've written a unique Christmas verse. If the editor likes it and uses it, I'll send you a copy. Meanwhile, Maurine joins me in our sincerest wishes that you all can make 1979 a truly new year."

John B. Welch celebrated his 90th birthday on December 12, 1978. He also writes, "It was with deep regret that I learned of Phil's passing. He was a fine fellow and I have pleasant memories of him at Tech and Class reunions. I still have the '13 Class year book with pictures of the Prom Committee. He has given his classmates a great deal of pleasure with his ample reports over the many years. It is fine of you to carry on." . . . Richard H. Bridge, '42, son of **Edward M. Bridge**, writes that his father is quite well — even rakes leaves and shovels snow — though his memory is not what it used to be.

We regret to report that we have been notified of the deaths of **Stanley Hodgman** on June 20, 1978, and **Charles E. Trull** on September 16, 1978. . . . We are also very sorry to report the death of **Bion L. Pierce**. His widow, Bunny, wrote us as follows: "Bion entered into eternal rest December 6 after a short illness. He was hospitalized three weeks. Bion was owner and proprietor

of the Pierce Hardware Company Store until his retirement 20 years ago. He was well known for his merchandising skill and when he sold the business, his successor found it difficult to achieve the same success and the business eventually folded. Bion was a member of the Charles H. Titus Lodge, Taunton Lodge of Elks and the Taunton Rotary Club, the Narragansett Bay Power Squadron and the Attleboro Power Squadron. He received many awards for his skill in the predicted log races. Boating was his hobby. I am sure we will find that our memories of our loved ones will be a constant source of comfort to us."

Notes received through the Alumni Association: From **John B. MacNeill**: "Mrs. MacNeill and I both in good health. Celebrated my 90th Birthday in June 1978. Visited Norfolk Navy Installation with grandson, Lt. Bob Eichelberger, in Submarine Service; also Cape Canaveral, Florida, with Mid'n Paul Eichelberger and family members. Golf not getting any better. See Mrs. Roy Block occasionally." And from **Walter P. Muther**: "It might interest my classmates that I have reached the pinnacle of my career — President of the Class of 1913 — unsolicited — The score, 3 to 1 — a "Jack-of-All Trades." I was able to innovate due to my education at M.I.T." — **Rosalind R. Capen**, Assistant Secretary and Treasurer, Granite Point Road, Biddeford, Maine 04005

14

By late January, eight members of our class said they hoped to come to our 65th reunion, and a second inviation was still to be sent. We hope that more will respond to it.

Word has recently been received of the death of **Russell A. Trufant** on February 4, 1976, at the age of 82. He was born in Whitman, Massachusetts, and was with us in Course I for three years. His early career was on irrigation works in Texas, the construction of Fort Knox in Kentucky, the planning of highways in Illinois, construction of a nuclear-engine laboratory in Connecticut, surveys with the Army Corps of Engineers in Rhode Island, and surveys and building construction in Massachusetts. From 1927 on, Russ lived in Middleboro and in Carver, Mass., engaged in growing cranberries and the related activities of designing and marketing bog railroads, prefabricated flumes, and pumps. He was responsible for the *Cranberry Almanac* and for other innovations, for one of which he was granted a patent. While he was in Texas, Russ was president of the Lower Rio Grande Engineers Club. After his return to Massachusetts he was chairman of the Middleboro Planning Board, a member of the Carver Planning Board, and served on various committees of each town.

He was also a member of the American Society of Civil Engineers, the American Concrete Institute, the Boston Society of Civil Engineers and the Cape Cod Cranberry Growers Assocation; a director of the New England Cranberry Sales Co.; and a Mason. He had written for *Cranberries* magazine, for various engineering magazines, and for newspapers in Texas and Massachusetts. In 1918 Russ married the former Elizabeth Dunavant Brown, who died in 1977. They left two daughters, Mrs. Thomas (Ella) Wolf, of Buenos Aires, Argentina; and Mrs. Edward M. (Carolyn) Colbert, of Brookline, with whom Russ made his home in his last years. Eight grandchildren also survive him. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

In the December/January *Review* our class was the fourth on the first page. We continue (sadly) to approach the old age status. Ugh! Thank you all for the many pleasant, cheerful, and friendly holiday cards you so thoughtfully sent me. I simply cannot write to answer them all, but I do appreciate your sentiments.

Bert Adam's daughter, Mrs. Peggy Marsh, writes that he died in Sewickley, Penn., December 29, 1978. "Until a few months ago he was active and able to live alone in his apartment near us, where he had lived for 60 years. After a fall last summer he had been unable to walk. His interest in M.I.T. and the Class of 1915 never waned and he never missed reading your class notes." Do you fellows remember how he entertained us at some Boston class dinners with his impressive and mysterious tricks? What a great guy! At one time, years ago, Bert was president of the American Association of Magicians, a position held by the famous Houdini.

Phil Alger's grandson, Monty M. Alger, graduated last June, making it three generations of Algers from M.I.T. — Phil Alger, VI, 1915; J. R. Alger, VI-A,1949; and M. M. Alger, VI, 1978 — a very proud family record.

Whit Brown wrote to wish me well and said that he and Marjorie are getting along well where they are in Georgia but hope to return soon to Concord, Mass., their original home. We'll be glad to see them again.

Evers Burtner sat with **Barbara Thomas**, **Wally Pike** and his daughter at the 1915 table lunch on Alumni Day. **Carl Wood** registered to go but couldn't make it. Maybe the rain kept him away. Evers' book, *Golden Age of Open Class Racing at Marblehead* (Mass.) *1906-1940*, is interesting with humorous tales of his experiences. He is, as you may know, a recognized authority on sailboats and was an official at a recent international yacht race. Like those other "snow birds" down there, he enjoyed a few months of 75° weather in Florida. Ah me! . . . Another one — **George Easter** on his Christmas card from Sanford, Fla., writes: "I have joined a couple of old folks clubs (mostly dances that I will avoid) and the local shuffle board club which looks a little more my style. Weather has been hot still — much better than last winter, but it is early yet. Take care of yourself."

Mimi Rice sent a nice Christmas greeting to the "finest class secretary ever." . . . **Jim Tobey** writes his usual "snow-bird" letter from Florida: "My daughter drove me from home in four days and three nights through much heavy rain. I'll be at Lake Worth during December and January. I cannot feel too sorry for the classmates "suffering in Florida."

Horatio Lamson writes: "I continue in good health and am active as a faculty consultant at Northeastern University. I also participate in the A.S.T.M. Committee on Magnetic Measurements. Vacation trips include Ottawa and Toronto, Atlanta and Orlando; a busines trip: Middletown, Ohio." . . . **Bob Warren**, president of the Early Birds of Aviation, recently participated in the 75th Anniversary ceremonies at Kitty Hawk, N.C., commemorating the Wright brothers' first powered flight on December 17, 1903. I see Bob occasionally and he looks fine. Probably, he is lucky to be alive after some of his experiences in pioneer flying.

Carl Wood is a busy and loyal citizen of Peterboro, N.H., where he is Civil Defense Director, Highway Department Consulting Engineer, an advisor to the town engineer, a member of the Water Resources Board, a member of the American Legion Cheney Post Number 5, and a member of the Masonic Lodge. What do you do, Carl, with your spare time?

Richard O. (Dick) Baily died September 17, 1978, in Berwyn, Penn.; **David M. Hughes** died August 18, 1978, in Los Angeles, Calif. The sympathies of our class goes to the families of these two departed classmates.

John Dalton loyally phoned me again from Providence. He is looking forward to golf if spring should ever come back to New England. He is still enjoying his retirement but will use a golf cart. . . . In wishing me good health, **Jerry Coldwell** says, "I hope you are now at the stage of jogging — maybe not the marathon but some short distance, like 15 miles." Can any of you design a motor drive for this cane I have to use? . . . **Otto Hilbert** is still happily working on composing a history for the Corning Glass Co., which he enjoys doing. He has time for a little traveling. — **Azel Mack**, Secretary, 100 Memorial Dr., Cambridge, Mass. 02139

16

It's timely to announce that we will celebrate our 63rd Reunion at the Chatham Bars Inn in Chatham on Cape Cod on June 5 to 7, 1979 — Tuesday through Tursday. Friday, June 8, is the big day for alumni at M.I.T. Make your plans now to be with us at Chatham for all or any part of the Reunion. We'll have the clambake at 1 p.m. on Wednesday, the Class Picture at 2:30 p.m. and the Class Banquet at 7:30 p.m. on Wednesday.

We're happy to acknowledge Christmas cards from : Jess Brophy, **Nat Warshaw** ("Going back to California on January 3, 1979!"), **"Shats" Ober**, Ruth and **George Maverick**. Margaret and **"Dip" McClure** write: "We keep breathing but have a hard time getting away from the top of the Blue Ridge. As a matter of fact we have not been really out of sight of the mountain in the past two years (30 to 35 miles). We had serious plans to come to the Reunion the last two years but finally could not make it. Still trying."

Our last letter from **Dina Coleman** (early October) indicated: "Week after next I am going to London for a week of opera, using the Concorde both ways. I am just too old to spend seven hours in a sealed capsule, crossing the ocean." . . . **Ken Sully** wrote, "We are active in playing and supervising the game of shuffleboard." . . . Had a nice letter from **Elsa Mueser** indicating problems with tornado, burglar, sewer and stolen suitcase but enjoying reasonably good health and joyously involved with her children, grandchildren and great grandson. "New grandson is son of M.I.T. Other grandchildren taking Ph.D. in Chicago; some at Columbia. Love and admire them all."

Mildred and **Art Shuey**, in their annual Christmas letter, gave us this brief account of their recent trip to China: "Something we have always wanted! In mid-July we were fortunate in securing visas for a 15-day visit to China, including Peking, Nanking, Shanghai, several farming communes, and the North China river port of Harbin and back to Peking and the Forbidden City there. We have never traveled among more courteous and pleasant people and we are sure that we were the oldest group of Westerners the young Chinese had ever seen and we were treated as honored guests, especially by the children." They, too, are completely involved with their children and grandchildren. One grandchild, Jim Shuey, "after two years apprenticeship on river boats, passed his River Pilots' Examination and now can pilot any freight boat on the inland waterways of the U.S.A. (shades of Mark Twain). He has now finished his first year at L.S.U. Law School." Among their other grandchildren is a doctor who will be a neuro-surgeon next September, a lawyer who is a clerk to a Federal District Judge in Lake Charles, La., a freshman law student at Tulane Law School, a nursing student at the University of Alabama, a pre-med senior at Centenary College, and another and his wife, who are students at Old Dominion College. We are saddened to know that Art and Mildred's son, Arthur, Jr., passed away last March.

Art also forwarded a letter he had received from **"Brute" Crowell**'s children in which they said: "He died about a year ago. We miss him but have happy memories of a wonderful man who maintained his sparkle and sense of humor to the last." Art wrote; "You must remember him: a Deke, architect, a wrestler at M.I.T., and later in Los Angeles he and **Jack Hepinstall** were partners in a contracting firm, mostly road building. He may have been Class of '15 and delayed graduating until '16."

Virginia and **Joel Connolly** observed their 60th wedding anniversary on January 16, 1979. Congratulations and best wishes for many more. Joel wrote: "I give more and more travel talks, (usually illustrated by slides), as word gets about that I am able and willing to give them. One I gave yesterday was 'Seeing the World by Plane and Elephant,' based on our fifth round-the-world trip."

As a final note, we regret to report the death of **Lewis M. Dow** in St. Petersburg, Fla., on November 19, 1978. Lew was with us at our 50th.

Keep breathing and keep your letters coming.

— **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, West Chelmsford, Mass. 01863

17

We deeply regret to report the death of **Thomas Meloy** on January 4, 1979. Tom had suffered a massive heart attack in September, 1978, and had made a good recovery. He had a remarkable career. Tom received his bachelor's degree from Harvard and then came for an engineering degree from M.I.T.; he also studied at the Sorbonne in Paris. He founded the Melpar Corp. in 1946 and later sold it to Westinghouse; at the time of his death, he was President of the Meloy Laboratories, Inc., of Springfield, Va. which was recently purchased from him by the Revlon Corp. He was also executive head of Isomet Corp. of Northern Virginia, engaged in laser development. Early in his career (1922) Tom spent two years in China working for the Chinese railway systems as a technical advisor and, on return from China, for the Bell Laboratories and the late Henry W. Stimson. In 1973 Tom received the National Capital Award for engineering achievements from the D.C. Council of Engineering and Architectural Societies. He helped establish the Woodrow Wilson Vocational Rehabilitation Center Foundation and was responsible for raising millions of dollars for the Center. He was an active member of the Arena Stage and was a member of the Advisory Board of the Center for Strategic and International Studies of Georgetown University. He recently wrote the foreword for the book *Carter on the Arts* by Joan Mondale. He leaves his wife, Claire; a daughter, Mrs. John Nussbaum of Darien, Conn.; a son, Dr. Philip Meloy, of Morgantown, W. Va.; and four grandchildren.

Joe Littlefield's Christmas card contains lots of information. His daughter, Melissa, married Timothy W. Carter, and they live in Canton, Mich., where he works for the Ford Motor Co. His son, Joshua, is in his second year at M.I.T. majoring in ocean engineering. Joe's wife, Doris, is a full Curator of Vizcaya Museum of the Decorative Arts and taking post-graduate work at the University of Miami. Joe offers a strong opinion on inflation and its cure: "Congress *can* end inflation by balancing the U.S. budget," he says.

Pat and **Bob Erb** are going to get warmed up in February on a Caribbean-Panama Canal cruise. . . . **Arthur Dickson** declares he is semi-retired but still keeps busy in the real estate and antiques business. . . . We are sorry to report that **Al Lunn** has been in Phillips House, Massachusetts General Hospital. His leg continues to bother him and he has had a slight stroke. **Stan Dunning** visited Al on January 9 and found him improving, but as of January 21 he was still hospitalized.

Interesting news from Elizabeth and **Ed Payne**. Their son, Roger, is a marine biologist and has his doctorate. He and his wife, Katy, are associated in this work and have an analytical laboratory in Lincoln, Mass. A part of his work is as a whale expert for the New York Zoological Society, lining up "stations" around the world to collect data on whales' migration, numbers, etc. Roger is the author of "Humpbacks: Their Mysterious Songs" in the January, 1979, issue of *National Geographic*; his research for the article was conducted in waters off Bermuda and Hawaii. To record a whale song, Roger and his team lower a pair of hydrophones into the sea and listen to a chorus of songs in stereosound through headphones. The songs — sounds that boom and echo — are so termed because they contain a regular sequence of repeated sounds such as made by birds and frogs.

Bill Neuberg was in Houston, Tex., the other day and called on **Dick Lyons** but found him absent due to illness. Here's hoping for his early recovery. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

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It is the end of January as I write these notes; much has transpired in the meantime. I am most pleased to have received season's greetings from so many of you, including **Jim Flint**, the **Howard Cyrs**, the **Leonard Levines**, the **Bill Fosters**, the **Charlie Taveners**, **John Kiley**, the **Sumner Wileys**, the **Granny Smiths**, the **George Sacketts**, the **Charlie Watts**, the **Wilfred Holts**, the **Tom Knowlands**, the **Paul McAllisters**, and **Ed Little**.

In response to my question about Proposition 13, here are some quotes. From **Rolfe Folsom**: "Proposition 13 is doing O.K. It has saved me a bundle, and I think our public servants are getting the idea." From **Mike Adams**: "Stop pay for not working and Proposition 13 goes out the window. End welfare and deficits." From **Arthur Williams**: "Kick everyone out of office every second term and start with new blood. No office holder to succeed himself more than once."

Edgar Goldstine tells it as it is in California: "I retired on December 31 after some 60 years of work, which seemed long enough. Proposition 13 reduced the taxes on our apartment from $1,989 to $777. Governor Brown is bearing down hard on the University of California. I understand their salary schedules which used to be about No. 3 in the country are now down to about No. 300, with some of the outstanding faculty either leaving or planning to do so. I voted against Proposition 13 because I felt some of its consequences might be disastrous. I feel our governor is not particularly competent, and his opponent in the recent election was no better."

Henry Stephens writes from Hawaii: "Cambridge and M.I.T. seem so very far away to one whose ocean travel is limited to a half-mile swim each morning and evening and daily exercise one-and-a-half hours each morning. My gainful employment is limited to one two-hour broadcast each week on radio station KNOI, called "Healthfully Speaking." I teach good nutrition and exercise as the right road to good health and long life. And I make a host of friends along the way. Why not vacation in Waikiki sometime?"

From **Clarence Fuller** comes this greeting: "This has been a sort of 'do nothing' year for me as it was in December, 1977; the doctor said I had better quit driving and to cut down on other activities. So I did! It seems to me that most of my present activities consist of eating, reading, and sleeping. Fortunately, I have visitors most every day, so I manage to keep interested in things, even the affairs of the Patriots. I had a nice letter from Eleanor and **John Kilduff** last week telling, among other things, about their 85-degree weather. Lucky, I say! It appears they are now well settled in Clearwater with a number of friends living nearby. Keep yourselves warm in the 'frigidair' weather and I hope that sometime before too long we will see each other again." We are happy to hear that Eleanor and John are enjoying the warm sunshine in Florida. Before they left this environment for their winter in the South, they established the John W. Kilduff Fellowship. This fund will support a doctoral student from the M.I.T. Medical Engineering and Medical Physics Departments to continue research at the Jackson Laboratories at Bar Harbor, Me., during a special nine weeks set aside for this purpose during the summer.

Through the kindness of Carol Seward, '47, we learn of the death of her mother, Louise Tucker. We can recall the many occasions when she and Carlton helped make our reunions more enjoyable. . . . We are advised of the passing of **Hampton Shirer** in July, 1977, by his duaghter. . . . There are a few longer season's greetings and comments which I will hold for the next issue. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

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Received from "Grandma" Olive and "Grandpa" **Bob MacMullin** a two-page newsy report of their doings in 1978. Boy, what activity! I can only quote a few excerpts: "Olive's second cataract operation in April, Bob's new hearing aids; the doctor monitors our decelerating metabolisms, but ad-

"They Put a Mask on My Face. . . and Led Me into a Field. . . "

By age 33, the late Tharratt Gilbert Best, '17, was safely established as a country gentleman and banker in Boonville, N.Y., and uneasy memories of a brief career at M.I.T. must have been fading, though they never died. A few of those memories are now revived in selections from Mr. Best's diary compiled and edited by his daughter, Virginia Best Clarendon (*Early Memoirs of a Country Gentleman*, North Country Books, 1976, $4 95).

Tharratt Best's accounts of M.I.T. — he came to Boston in September, 1915, having graduated from Princeton four months before — range from lackluster to melancholy. One of the optimistic entries came early, when Alfred E. Burton, who was then Dean of Students, saw his "graphic (plates)" and "cancelled all graphics" requirements.

There is a vivid description of the initiation into Phi Beta Epsilon: ". . . they put a mask on my face and an old hat on my head and led me from the house to an auto. . . . We went west, I think, and after half an hour they stopped and led me from the car into a field, where they told me to lie down and count to 88, then go home and report tomorrow. . . . I found myself in a field near a road, with no houses in sight, and the moon shining, and it was getting cold. . . . At least I found a house with lights, and asked the way to Boston. Was going the right way and was 12 miles away. . . . I arrived at 2 a.m."

The grade reports arrived in February, "and mine wasn't great." Three days later Professor William E. Wickenden ". . . advised me to take a leave. . . . He said he doubted if I was the sort of man to be an engineer and advised me to think about it seriously before fall. Now I don't know where to turn, but I'm not discouraged."

In the following years there was work for General Electric, a career with the American Field Service in France during World War I, a year in the new oil fields of Oklahoma, and finally the life of a country gentleman and bank president in rural New York. But until he died in 1969, M.I.T. was always in Mr. Best's memory; he returned once, in 1920 — to a warm welcome at the P.B.E. house and a tour of "the enormous and marvelous building" in Cambridge.

(Copies of *Early Memoirs of a Country Gentleman* are available from the author at Box 518, South Orleans, Mass., 02662, at $4.95 postpaid.)

vises us to keep working. That's great with us, for our minds are still young." Also, at the Electrochemical Society meeting in Seattle "a charming Englishman, Francis J. Bacon, received the Electrochemical Engineering Award for his development of the fuel cell that powered our space satellites (Bob got it in 1976)." I wish there was room for much, much more; they plan to attend our 60th Reunion.

Doc Flynn expects to be with us at our 60th. . . . **Francis Weiskittel** hopes to see someone from Course XV at the Reunion. . . . **G. R. Bond, Jr.** reports good health, community activity and lots of travel; expects to be at the Reunion. . . . Word from **Don Kitchin**, who is now 83, is able to get around and to play his piano. Good work, Don. . . . **Dick Holmgren** is back from one of his trips to his beloved Northwest. . . . **Erwin Kenison** writes, "I shuffle six times a week, play bridge, euckre, and rummy. I feel pretty good." . . . **Fred Hewes** would like 1919 readers of this column to know that he is still about and while he doubts that he can attend the Reunion due to his wife's inability to travel such a distance, he would welcome classmates knowing his address at 1195 Thruston Ave., Los Altos, Calif. 94022.

Sadly I report the deaths of three more of our 1919 classmates: **Paul D. Sheeline**, **Harry Stiller**, and **Charles A. Chayne**. A letter from **George Michalson**, who attended Paul's funeral, advised me of his passing; he died of cancer at the Massachusetts General Hospital. Paul served his country in the military service, and M.I.T. in many activities including those related to our class; his many friends, including me, and his beloved family. We shall all miss him. Harry Stiller of Cranston, R.I., died on September 3 after a short illness. He was retired from the Stiller Carpet Co. of Providence which he founded. A letter from Nancy Chayne Martin informs me of the death on October 30 of her father **"Charlie" Chayne**. After several employments following graduation, Charlie in 1930 became head of the Buick Motor Division and advanced in 1951 to become Vice President in charge of Engineering. During this time he made many noteworthy contributions to automotive engineering in all its phases. He served on many committees and groups in the Society of Automotive Engineers, including the University of Michigan which awarded him an honorary degree in engineering. His service on the M.I.T. corporation is widely known. He had a hobby of collecting and restoring antique automobiles, some of which are now in permanent museum collections.

When you may read these notes, you will have received separately particulars of our 60th Reunion. If you have not already responded, kindly do so now. Hopefully, you will plan if at all possible to attend this important reunion, important in several ways but particularly in Time. It will be an on-campus reunion with quarters in the comfortable Hyatt Regency Hotel located near the Institute on the Charles River in Cambridge with convenient transportation arrangements to the M.I.T. festivities on June 7, 8, and 9 of this year. Hoping to see most of you and to hear from all of you, I sign. — **William Langille**, Secretary, Box 144, Gladstone, N.J. 07934

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Your greetings for the new year gladdened the heart of your secretary. Many came from Florida: Beth and **Ed Ryer**, Florence and **Lee Thomas**, in Naples at Kingsport Club; **Frank Badger** from Hollywood, who hopes to get up here for Alumni Day; Barbara and **Bill Dewey** in Pleasure Island, who also look forward to making it in June. Bill mentions that they had a fine trip last spring to Colorado Springs to attend their grandson's graduation from the Air Force Academy. They came down on the auto train and ran into the Ryers at the unloading point. From his estate near Paris, **K.B. White** says he is now almost completely retired and spends most of his time in the country.

Closer to home were cards from Betty and **Norrie Abbott**, Marge and **Stan Reynolds**, Billie and **Dick Gee**, Pat and **Buzz Burroughs**, Mina and **Perk Bugbee** and **Ned Murdough**. Just before Christmas, Mary and **Buck Clark** celebrated their 50th Anniversary with a host of friends at their home in Farington, Conn. Representing the class were Betty and **Norrie Abbott** and Mina and **Perk Bugbee**. Buck is still active in the investment business with an office in Hartford. . . . Another who remains active is **Gerry Tattersfield** who is engaged in wool imports in a sales and consulting capacity dealing in processing various synthetic fiber wastes for reuse. Gerry has been in this field since 1922.

It is gratifying to hear from old friends in the class such as **Henry Massey** of South Chatham on the Cape who remains active enough to continue paying social security taxes, does some fishing, and got himself in a group picture of no less than fourteen of the Massey family last summer. "Hurrah for Cape Cod," says Henry. . . . **Hank Caldwell** and his wife Emma write that they moved to Tampa to a 24-story retirement home last fall which they consider "super." Full of energy, Hank is working on a scheme to convert radioactive waste to another form of energy that would be less harmful. Meanwhile, he is busy designing a new form of sail for his sailing craft. More power to him!

From a senior residence in Falmouth, **Al Wason** writes to proudly announce a second great-grandchild. Al has one grandson and three granddaughters. . . . **Harold Bibber** writes that he and his wife seem to have developed a routine of spending four months of the winter in Florida and the balance in Columbus, Ohio. Not a bad routine, Harold. . . . **George Wilson** of Braintree, Mass., admits he is slowing down a bit but continues active with his various hobbies. He still maintains a large collection of good minerals. . . . Ann and **Bink Carleton** haven't let up a bit with their worldwide travels. Last spring they took a continuous ship cruise to Australia and New Zealand, and this fall they spent a long visit in Heidelberg, Germany, where their eldest son is managing engineer with Sikorsky Aircraft.

Herman Marrow writes from Tampa that he is still playing golf and working at the hospital. . . . **Frank Maconi** of Leominster advises that he is active in SCORE, Tri-City Chapter, and is on his church investment committee. . . . A worthy tribute to **Ed Burdell** appeared in the minutes of the trustees' meeting at Cooper Union. "Resolved, that there be spread upon these minutes testimony of the sorrow of the trustees at the death on August 30 of **Edwin Sharp Burdell**, director of The Cooper Union from 1938 to 1951 and president from 1951 to 1960. Distinguished humanist, educator, and able administrator, Dr. **Burdell** will be remembered at the Cooper Union for the broad scope of his educational aims and for the care with which he preserved the ideals of Peter Cooper. Intellectually alert, thorough, patient, forthright, just and honest as an administrator, it was his humanistic approach to education that is recalled most readily by those who were privileged to know him. His leadership, devotion, and firm principles will be long felt, remembered, and appreciated by The Cooper Union."

At a stopover in St. Louis, Amy and I had a pleasant telephone visit with Vera Howes, widow of our late, great **Homer Howes**. Vera, an inveterate traveler, was about to depart for Cairo. . . . We have word of the death of **Ben Hopkins** of 5330 Harroun Rd, Sylvania, Ohio, on August 20, last. He is survived by his wife. . . . **Bob Bradley**'s wife Ruth phoned to tell us the sad news of **Dick Gee**'s death on January 27. Dick, who lived at 347 Smith Neck Rd., So. Dartmouth, Mass., was without question one of the best liked members of the class. Dick was a pioneer in the successful development of fiberglass boats. A salt-water yachtsman for most of his life, he skippered many a coastwise cruise for other old salts in the class, such as **Buzz Burroughs**, **Ed Ryer**, and **Tony Anable**. All who came in contact with him were the better for his buoyant spirit and zest for living. His loss is a grievous one for the class and we express deepest sympahty to his wife Billie. — **Harold Bugbee** — 21 Everell Rd., Winchester, Mass. 01890

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It is with deep sadness that we report the death of our class vice-president and treasurer **A. Royal Wood** on January 10, 1979. He suffered from cancer for the past year and was in and out of the hospital several times. Woody graduated with our class with B.S. and M.S. degrees in electrical engineering. Later he took accounting courses and became a C.P.A. After graduation he worked for several years with Philadelphia Electric, taught for two years at M.I.T., was employed by Lybrand Ross Brothers and Montgomery from 1928 to 1939 and then joined United Illuminating Co. of New Haven, Conn. During his career he became secretary and treasurer of United Illuminating and retired as vice president of that company in 1965. His outside interests included working as treasurer for Davenport Residence, a middle-income apartment project; as chairman for the Phelps Community Project for elderly people; and as a trustee of the Whitney life care center where he and his wife Winifred had planned to move in February. Our deep sympathy is extended to his family.

The death of another well-known member of our class, **Lawrence W. Conant** of Washington, D.C., came on January 16, 1979. Larry worked for the Army Corps of Engineers for many years and then for the Federal Aviation Agency from 1950 until his retirement in 1965. After moving to Washington in 1932, he began working with youngsters as a scoutmaster, camp counselor and founder of the Dad-Coached Clubs. His work with the Dad-Coached Clubs was featured in a 1949 article in the *Saturday Evening Post*. After retirement, Larry began studying cybernetics and did considerable research in this field. Our sympathy goes out to his wife Dorrit.

Betty and I wish to thank the many people that sent us Christmas cards and in particular those who sent us news. Helga and **Jim Parsons** wrote that they had just returned from a six week cruise starting at Vancouver, up to Alaska, across the Pacific to Japan, China, Singapore, Bangkok, Hong Kong and then back to San Francisco. . . . Marion (Mrs. **George**) **Chutter** mentioned seeing Helen and **Bob Miller** several times last spring. She also told me Millis (Mrs. **Don**) **McGuire** died during the year. (Don, we're truly sorry to hear this.) . . . My college roommate **Hobart Fisher** celebrated a 50th wedding anniversary last April at Daytona Beach. It was a big shindig with about 100 guests. He and Gladys flew to New Hampshire in June to attend their granddaughter's graduation from nursing school. . . . Betty (Mrs. **Norman**) **Patton** spent a week at Maitland, Fla., last February and during the summer took a 3,000 mile motor trip through northern New England, New Brunswick and Nova Scotia.

Emma and **Al Lloyd** wrote, "Our only trip this year was to Virginia and Georgia to visit children and grandchildren. Helen and **Bob Miller** drove over to McLean, Va., one afternoon. Helen has done very well since a heart by-pass operation last summer. You may have heard Bob was at the Cape Cod Hospital with pneumonia last June and had a tough time for several weeks.". . . Anne and **George Schnitzler** took a Scandinavian trip last summer, "hectic but very rewarding." . . . Graciela and **Helier Rodriguez** wrote: "It was delightful driving to Boston in October to attend the Alumni Officers Conference. The fall colors were beautiful. Our trip was cut short by heavy rain so we rushed back to Washington and then home. We were sorry not to have seen you and we also missed seeing Helen St. Laurent." . . . A note from Dorothy (Mrs. **Joseph**) **Wenick** said: "My son Martin was on a recent mission to Moscow with Secretary Blumenthal. Martin has bought a house in Washington and is now assigned there. I expect to be in my apartment at Coconut Creek, Fla., after January 15."

A card from **Wally Adams** said, "we heard from Ocy and **Al Breed** and they are as usual. Margaret (Mrs. **Edwin**) **Clark** wrote me that Ed's condition was unchanged — he has been ill for some years." Wally's Christmas card had a colored photograph of their church, taken by him. "The

church tower and a 40-foot addition to the nave were a project I took on when I retired. **Art Harvey** of our class helped materially with the financing." . . . Maida (Mrs. **Edouard**) **Dube** wrote in their family Christmas letter: "This season of peace and hope is perhaps the best time to tell all of you how much your notes and letters meant to me. You all remembered Edouard in different ways and your sharing of memories has meant so much. Many people knew that the greatest and best part of my life was spent so happily with a man who was the gentlest of gentlemen." . . . Helen and **Bob Miller**'s Christmas card contained seven photographs of three generations with brief notes on the family doings. Bob and Helen plan to fly to Mexico in February to visit with their daughter's family in Mexico City. They also will spend some time in Cuernavaca. . . . A post-Christmas note from Hazel and **Whit Wetherell** reported hospitalization and surgery for Hazel in mid-December from which she is recuperating well. Their family came and took over preparations for Christmas and cooked all the meals. Hazel said they had one of the best family visits ever.

Our class Secretary-Treasurer Emeritus **Carole A. Clarke** and his wife Maxine celebrated their 50th wedding anniversary with a gala cocktail party, dinner and dance on December 16. Over 100 people attended including Vina and **Ray Cooper**, Alex and **Munroe Hawes**, and Betty and **Sumner Hayward**. Our red M.I.T. jackets were the order of the day. It was a grand affair. Car continues to write for the Brielle newspaper and has promised to send me some clippings. . . . A letter from Assistant Secretary **Josh Crosby** in early December told of a circuit tour around Florida that he and Claudia took in late November. They drove over to the east coast to visit a brother and then down to Key West. On the way home they talked to **Phil Coffin** and **Jim Parsons** in Naples and reported all is well. They stopped for a brief visit with Marion and **Phil Payson** in their new home in North Fort Myers and also drove out to Sanibel Island to see the **Rod Eskews**. Rod has had an interesting career with Hercules Powder, DuPont, and finally the U.S. Research and Development Laboratories in Philadelphia, where he was chief engineer. Rod had a serious horseback riding accident some time ago so it is difficult for him to get around.

We have been notified of the deaths of five other classmates: **Robert R. Whitehouse** of Unity, Me., on June 28, 1976; **Thomas B. Card** of Boston, Mass., on December 23, 1977; **Richard H. Morris** of Santa Monica, Calif., on July 30, 1978; **Carl A. Ellis** of Waltham, Mass., on August 24, 1978; Reverend **William F. Hastings** of Fredonia, N.Y., on November 1, 1978. As your secretary is writing these notes in Sarasota, Fla., without benefit of his files, he is unable to supply information on the careers of these classmates. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33579; **Samuel E. Lunden**, Assistant Secretary, Lyon Associates, 453 South Spring St., Los Angeles, Calif. 90013

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To enlarge on our last report of seasonal greetings: we have received season's wishes from Catharine and **Mac McCurdy** picturing Lochland, their beautiful Mercer Island home, a scene we enjoyed from their cruiser a few years ago. . . . The family picture of the **Bill Elmers** recalled the punch bowl trophy given at the 40th Reunion for the Class member with the youngest child. Now Ned has graduated from Phillips Andover (in 1976) with four prizes and won his Phi Beta Kappa key at Johns Hopkins last spring as a junior, in his second year there — a remarkable record. Bill tells us his book on reflectors is being published by John Wiley. But the best item is that he doesn't look any where near that old. Congratulations to the three Elmers.

A beautiful greeting card from Madeline and **Parke Appel** tells that his President's letter to the Class is on the way. This newsy epistle tells all and suggests a contribution.

Carlos and **Frank Kurtz** are hospitable folks who are still busy at tennis and bridge in Delray, Fla., and attend M.I.T. meetings at Palm Beach. It sounds like a happy vigorous life without the agony of golf.

William H. Mueser of New York City received honorary membership in the American Society of Civil Engineers at the annual convention in Chicago, Ill. The award is the highest bestowed by the 126-year-old Society.

We received two lengthy newspaper articles printed in the *Hallandale Digest* from **Oscar H. Horovitz** about Colonel **Ray C. Burrus**: "After the programmed presentations were made at the annual banquet of the Hallandale Chamber of Commerce at the Diplomat Country Club on the evening of December 6, 1978, outgoing Chamber President Joseph A. Hanff, Jr., made a surprise award: a Certificate of Appreciation recognizing Colonel Ray C. Burrus for 'his outstanding and unique contributions to the Hallandale Chamber of Commerce; he is hereby appointed to a lifetime membership on the Board of Directors.'" This award was the first of its kind in the 25-year history of the Hallandale Chamber of Commerce. Congratulations Colonel!

A letter from Robert F. Packard, '53, Chairman of the Planning Board and Project Director of the town of Wareham, Mass.: "In 1922, a group of five M.I.T. seniors wrote a bachelor's thesis on a combined steam and hydroelectric power plant for the village of Remont, a section of the town of Wareham. The hydroelectric plant was built and run for a short while; then the steel works below the dam was discontinued and the electric plant was later dismantled and shipped to South Carolina where it was re-erected and run for many years.

A couple of years ago, the town of Wareham received funds to restore and rebuild the earthen dam, the concrete spillways and other structures, the wooden gates, the operating machinery, and the foundations and the power house itself; now the mill pond water is mostly used as a reservoir for flooding the cranberry bogs. But now we have a grant from the Department of Energy to study the feasibility of re-installing turbines and generators at Tremont Dam. The project looks very good and sound economically. The following names were on the thesis on 1922: **Donald P. Knight**, **A. L. Wasserman**, **Frank H. Wood**, **Maurice W. Williams**, **Royal A. Stone**. They might be very interested to know what happened to their project. If we ever get the electricity flowing again, maybe we could get them to dedicate it." If anyone has any information, please respond to Mr. Packard or to your Secretary.

We have a note from **Edward J. O'Connor** who is spending his winters in Florida at Delray Beach and the rest of the year in New England. He is a director in his son's construction equipment company. Ed still plays golf, and his handicap is 13.

Robert L. Hallock recently published his book *Inventing for Fun and Profit* with Crown Publishing. It is now being used by the M.I.T. Innovation Center and has gone into a second printing; an article summarizing it will soon appear in the *Technology Review*.

From **Abbott L. Johnson**, Apt. 11C, 2201 North Central Ave., Phoenix, Ariz. 85004: he will be in Phoenix until May and is inviting all classmates out to Phoenix for a golf game. Abbott's number is listed in the Phoenix telephone book.

The sympathy of our class is extended to the families of **William G. Hodges**, 39 Ledgelawn Ave., Lexington, Mass.; **Samuel H. Conrad**, Fort Ward Towers, 2500 N. Van Dorn St., Alexandria, Va.; and **Roger C. Bacon**, 7 Edison Ave., Medford, Mass.

You all will be happy to join in celebrating the fact that Buffalo had no winter until January. With happiest of spring greetings to you all and a constant request for news, hopefully. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

Diggers in the Deep Earth

If you're big enough in heavy construction, you may qualify for membership in the Moles, a national organization of men who have built tunnels, subways, foundations, and underwater projects.

And if you're good enough at the job, perhaps you'll qualify for The Moles' Award, "to honor outstanding ability and accomplishment in the heavy construction field." That remarkable honor came this winter to Horace W. McCurdy, '22, Chairman of the Board of the Puget Sound Dredging Co. "During his long and distinguished career in civil and military construction," said the citation, Mr. McCurdy "has contributed significantly to the development of the Pacific Northwest." Among those present for the ceremony in New York on January 31: James G. McCurdy, '48, who is now President of the Puget Sound Dredging Co.; William H. Mueser, '22, partner in Mueser Rutledge Wentworth of New York; Paul E. Gray, '54, Chancellor of M.I.T.; and Ross J. Smith, Director of Athletics at the Institute (Mr. McCurdy was an outstanding athlete as an undergraduate and has maintained an active interest in the athletic program ever since). The picture shows Mr. McCurdy (right) receiving his plaque from the Moles' Dan S. Brock.

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Ecuador's consulate in Boston reports that the run-off election for president, in which **Sixto E. Duran-Ballen** is one of two candidates (see November Notes) will be held next April and that the winner will take office in August.

Suggestions for our 56th Reunion should be sent directly to **Royal Sterling** whose address through April is Apt. JJ-3 Vista Pines, 2600 S.E. Ocean Blvd., Stuart, Fla. 33494. . . . **John C. O'Flaherty** reports a new address: 4360 S. Alton Court, Englewood, Colo. 80111. . . . Brigadier General **Willis Slaughter** reports a new address which he says will be his last move: Box 255 Cumberland, Kendall at Longwood, Kennett Square, Penn. 19348. . . . **Winchester Blake** writes: "While I have called myself Class of '23, I entered Tech in 1918 and spent three years with the Class of '22, at the end of which my funds became a negative quantity. I was able to return later and graduate with '23. I have friends in both classes. My main hobbies have been out of doors, but at near 80 I am at some loss."

Miles Pennybacker writes, "I was a delegate to the National Democratic Conference in Memphis in early December. I was glad to see there was substantial resistance to President Carter's proposed cutbacks in needed health, education, and other social services, and to his proposed increase in arms." . . . **Ida Webster** reports from New York that she is still a partner in Weiss, Whelan, Edelbaum, and Webster, Architects. She is also vice president of the Citizens' Housing and Planning Council and a board member of the Women's City Club.

Norman Weiss reports that his family had good health in 1978. He is tapering off his consulting work as well as his work on the *Handbook of Mineral Processing*, which has been approaching completion for the past year. A consulting job in Australia and Papua/New Guinea occupied his time during late 1978. . . . **Bert McKittrick** reports the death of **Forrest Lange** on January 11. Forrest graduated in mechanical engineering with our class. After graduation he joined the Linde Air Products Co. in Buffalo, then for a time was an instructor in English for the Institute, studied communications at the Bell Telephone Laboratories in New York, and later became chief draftsman for the Prest-O-Lite Co. in Indianapolis. Ultimately he established his own business as a registered professional engineer, consulting in the design and manufacture of refrigerated display cases. In 1941 he was appointed acting chief of the Engineering Division of the Ordnance District in Springfield, Mass., and in 1943 served on the War Production Board in Boston as chief of production. He then served with the Reconstruction Finance Corp. for appraising industrial plants in New England and with the Federal Housing Administration in Boston.

After the war he served as senior consultant and analyst of the Management Planning and Review Department at the Portsmouth Naval Shipyard. He served as secretary-treasurer of our class from 1963 through 1968, was chairman of the Alumni Fund for the Portsmouth, N.H., area and also of the Second Century Fund for the seacoast region of New Hampshire. He was a life member of the American Society of Mechanical Engineers and the National Assocation of Naval Technical Supervisors, being president of the Portsmouth chapter and national vice president. He was a national trustee of the Sons of the American Revolution and an advisor to the National President General of the Daughters of the American Revolution.

Mrs. Joseph A. (Phyllis) Stern reports the death of her father, **Herman Swett**, in Pasadena, Calif., on December 6, 1978, after a long illness. He graduated with our class in biology and public health. After graduation he was in charge of the Boston office, Processed Foods Inspection and Grading Service, U.S. Department of Agriculture. He then moved to the Department of the Interior in charge of the North Atlantic Region, Fishery Products Inspection and Grading Service. Later he became plant manager for Boston Bonnie Fisheries.

The Alumni Office reports the deaths of **Donald Moriarty** on August 5, 1978, and of **Harrison Shaler**, on November 18, 1976. Donald graduated in mechanical engineering with our class. No information is available about his subsequent professional activities. Harrison was a graduate of the United States Military Academy. As a lieutenant, he was assigned to the Ordnance Department, U.S. Army, at Raritan Arsenal, Metuchen, N. J., and as a captain he was assigned to the Ordnance Department, Savannah, Ga., and later the Delaware Ordnance Department at Pedricktown, N.J. As a major in 1941 and a colonel in 1943 he was in the Adjutant-General's office of the War Department in Washington, D.C. He became a brigadier general in 1958. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, Mass. 01890

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Notes received on the back of Alumni Fund envelopes. **Chris Conway** says, "I keep busy with church, civic work, and club activities. My main hobbies are gardening, theatrical, and concert productions. The oldest of my four grandchildren entered college in September, 1978." . . . Dr. **Mal Finley** just returned from a freighter trip to the Mediterranean on *S. S. Young America*. He got some writing done on "The Neurophysiology of Human Relations" and visited Planet Ocean Museum in Miami. "Don't pass it up; it's fascinating." . . . **Curly Fletcher** says, "It's nice and peaceful in this part of Florida. No news is good news." . . . **Dave Kanter**: "Among my many rewards on earth is the matriculation of a grandson, Michael Fink, who is in his sophomore year at the Institute." . . . **Robert Bruce Lindsay**: "Editor-in-Chief, Acoustical Society of America; Honorary Fellow, British Institute of Acoustics; Honorary Sc.D. from Brown University in physics, 1978." . . . **Bill MacCallum**: "We will be in Cotuit, Mass., this winter except for a February cruise to Egypt and Israel with the M.I.T. Quarter Century Club on the *Atlantis*. (A mid-January report from Eleanore indicates that Bill met up with a scalpel-wielder, unexpectedly, and would not make the boat.)

Jack McCoy: "I've been ill for over five years." . . . Dr. **Wm. Earl Messer**: "My wife Marian died on September 19, 1978. She wanted to stay in her home and not a nursing home, so I cared for her for three-and-one-half years, up at 4:00 a.m. and in bed at 8:00 p.m. She was 86 years old and I am 77." . . . **Ed Moll**: "As 55th Reunion Chairman, I am busy for the June, 1979, festivities." . . . **Cam Ross**: "I'm still doing consulting work for W. R. Grace Co. at their Lexington, Mass., laboratory after 50 years of continuous work with them." . . . **Edward A. Saibel**: "I received the Mayo Hersey Award from the A.S.M.E. in December, 1978." . . . **Jack Walthall**: "Eva and I hope to make the 55th Reunion in June."

Capt. **Chester V. Jones** (U.S. Army retired) died in Portland, Ore., on December 25, 1977. He spent three years in the electrical engineering course and returned to the Army Signal Corps, making it his career. He was a member of the Amateur Radio Relay League, Masons and the Armed Forces Communication Association. . . . Belatedly, we have word of the death of **Kenneth M. McDonald** on February 20, 1976, in Birmingham, Ala. He received his S.B. in electrical engineering and a Ph.D. from Vanderbilt. He spent some time in the U.S. Army, owned and managed real estate, taught at several colleges, and designed equipment for steel and aircraft plants. . . . **Frank W. Warren** passed away November 26, 1978, in Murray Hill, N.J. He received his S.B. in mining engineering, entering from Williams College. Associated with Merck and Co. of Rahway, N.J., most of his life, he retired in 1965. He was an enthusiastic fisherman and outdoorsman often roaming in Vermont.

You all have about two months to accumulate cash for the 55th Bash, beginning June 6th. Your secretary suggests that $100 per person, modified by liquid and diet, will cover Boston area frivolities. **Frank Shaw** and **Ed Moll** will be sending you a more accurate cash flow summary. **George Glennie**, Andover, Mass., because of his interest in historical societies and antiques, will be chairman of the 1979 nominating committee. He particularly favors golfers.

Attending a business luncheon January 13 were: **Don Moore**, Dot and **Ray Lehrer**, Rene and **Ed Moll**, Hazel and **George Glennie**, **Gordon Joyce**, Helen and Prof. **Irwin Sizer** (Honorary '24), Nona and **Web Brockelman**, **Herb Stewart**, **Frank Shaw** and **Russ Ambach**.

Stringer Sinnicks, in Santa Rosa, Calif., kindly writes a three-page letter (good reading) detailing his career. Last year pneumonia gave him a tough two months, and in 1977 Grace had a heart mitral valve replacement.

Roland (Bobus) Black writes: "Martha and I keep busy puttering around our place inside and out and have many social, church, and voluntary activities, although experiencing the creaks and minor miseries of aging. We look forward to the reunion in June." — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, Co-secretary, 8 Pilgrim Rd., Waban, Mass. 02168

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I'd like to thank the several classmates who sent me greetings during the holiday season. With the greetings came some news items which provide material for these class notes.

Kamy Kametani reports that he is helping a young man at the Hino Automobile Co. who is preparing research papers on noise and vibration of the Hino diesel automobile. Kamy refers to this as something to keep his brain working. . . . **Sam Spiker** writes that he has deserted New Hampshire for much of the winter, moving to Longwood Towers in Brookline, Mass., through mid-February and then taking off for destinations undisclosed through March. . . . President **Chink Drew** tells us that he has become an expert with the hedge clippers and keeps the shrubbery trimmed at New Castle, N.H., during the summer and at Laguna Niguel, Calif. during the winter. He reports, also, that Lil broke her leg this past summer rescuing a pet duck from a pursuing dog in the tidewater bay at New Castle, but has recovered.

Broken bones seem to have been too common in 1978. My good wife Evelyn cracked her ankle last winter (broken wrist the year before) and many of her friends did likewise. When **George (Count) Blonsky** heard of this he turned doctor and prescribed special diets emphasizing cabbage, milk and rice to prevent further such incidents. George reports that he and Lotta are doing quite well but have to fight their weight and George has to read with one eye — the other has a cataract and as yet he is shying away from an operation. . . . Ruby and **George Washington** remind us that another reunion is due in 1980. Katherine and **Hal Halliburton** sent greetings from Nevada, Mo. but did not report on any of their activities. . . . **Jim Howard** sent greetings, also. If you haven't as yet sent your contribution to the Alumni Fund this year take care of it shortly and you will get a nice note from Jim. — **F. Leroy (Doc) Foster**, Secretary, P.O. Box 331, North Chatham, Mass. 02650

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As we approach the anniversary date of the famous blizzard of '78 the elements have decided to give us a test run with a check on the new seawalls. A wild northeast storm this week had most of the features of last year but thankfully a couple were missing. This time the temperature was above freezing so the air was not filled with snow and we could see what was happening. Since it is was not the full of the moon the tides were not high. But it still was wild with 20-foot waves coming straight at us and breaking on the rocks below with enormous force. It is an ominous spectacle and one I wish I could share with you. Even this week's storm had all of the qualities without the devastation. We have been without

telephone service for three days which did not happen during the big blizzard. As the three days passed we suddenly discovered that the telephone company has been "modernized." Personal contact has been lost and computers have moved in, giving promises that were never kept and stereotyped information. Thanks to living in a small community we know the local pole climbers and in desperation called one for help and got taken care of immediately. Computers are great, provided one does not have to confront them. I'm sure the enormous systems would collapse without them. Let's hope they don't collapse with them.

An essay was not planned when we sat down with the notes so let's get on with our assignment. This week we attended our first Alumni Council meeting in a year and a half due to a perennial back problem that settled in the leg that pushes the accelerator pedal. A left-footed accelerator plus an invitation from Courtenay Worthington, '25, to ride with him removed all obstacles. It was great to get together with Class Agent **"Pink" Salmon**, Class Vice President **Bob Dawes** and Reunion Chairman **Don Cunningham** prior to the meeting. Mary Salmon also joined us because of interest in the subject (modern weather forecasting). Pink and Mary visited son Bill in Majorca last August and just before leaving for home Mary broke her ankle but she was well mended and lacked any semblance of a problem. Bob Dawes' Evelyn is currently recovering from a back problem but "Pink," Bob, and Dave appeared disgustingly healthy.

We have told you before about **"Dave" (Crockett A.) Harrison**'s Christmas brochures — always fantastic productions. This year eight pages, eight photographs and a complete family directory. A previous letter from Dave tells of his personal activities during the year so we quote from his letter: "My wife and I spent four weeks in the Orient — Japan, Taiwan, the Philippines, Singapore, Bali, Bangkok, and Hong Kong; our first experience with a fully conducted tour. This trip, incidentally, completes all six continents for us. Only Antartica is left and we haven't decided whether we want to try to include it. It was quite an experience to unexpectedly encounter a first cousin in the lobby of the Imperial Hotel in Tokyo. She, Dr. Anna Jane Harrison, who is one of the rotating chairmen of the Chemistry Department of Mt. Holyoke College, is also the current president of the American Chemical Society and was in Japan as a guest of the sister society of Japan. **John B. Jacob** and his wife Harriet are currently on a cruise around the world. We get cards from them from time to time. The last was from Suez, Egypt, while awaiting a convoy to go through the Suez Canal."

There have been a number of deaths reported from the Alumni Register. Sometimes these do not show up for many years if there is no contact with the family. We had tried to contact **Bob Glidden** at the time of our 50th and only now learn that he died in 1969. **William M. Walworth** died a year ago in Lansing, Mich., and **William L. Freeman** died in Oregon in 1976. **Malcolm Jenckes** of Essex, Conn., and **Joseph B. Merrick** of Providence died in 1977. Reporting the deaths usually signals the end of the class notes and since the sun has dropped behind Pigeon Hill, the temperature is also dropping and most of all mail is collected at 5 p.m. This calls for our cherrio until May when we hope to report that spring is in the air. Please write! — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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You will understand why this month's notes are so brief when I tell you that I am writing them, in early February, from a New York City hospital where I have been since Thanksgiving. A couple of weeks ago, the doctors gave up hope of saving my left leg, and it was amputated. The prognosis is good, and I am going to try to catch up on any delayed news in the next issue of the *Review*. — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

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Many of you will be pleased to know that Nicholas Ralph Jope arrived safely and well on December 5, 1978 at Heatherwood Hospital in Ascot, England. His parents also came through the event exceptionally well. Young "Nicky" is the fourth grandson of our deceased class president and the second one eligible to carry on the family name. Florence and I, as grandparent(s), spent the entire month of December in England assisting where and when we could. As a consequence our usual holiday mailing had to be omitted. However, we hope that we will have responded to all of your many kind greetings by the time you are reading these notes.

Apparently nothing stimulates the spirit and enthusiasm of a good class more than a resounding reunion. Our 50th did just that and much of the correspondence since June continues to comment happily on that memorable week. Perhaps the present level of interest will promote more class meetings in local groups (mini-reunions). Of course, this is done now to some extent and many traveling classmates do take the opportunity to contact others along the way. We are always pleased to have reports of such meetings.

Peggy and **George Mangurian** took a two-week trip to Greece last October and enjoyed the various cruises and sights for which that country is famous. They spent a day and a night visiting with **John Houpis** in Corinth where he operates a small citrus farm by himself. John was reported to be "looking great." . . . Olivia and **Warren Fleming** were disappointed not to attend the reunion last June because of Olivia's arthritis; they do hope to be at the 55th. Warren continues to be well and keeps busy with the Corning, N.Y., Rotary Club. He goes duck hunting each fall on his cousin's island in Lake Huron in Canada. . . . **Paul Martini** wrote with his contribution to the Alumni Fund, but his letter was confined wholly to the business subject. We infer and trust that all is well with him and Catherine and hope he will write again with some personal news. . . . **Frank McGuane** also wrote mostly on a business basis, but he did say that it is a joy and a privilege for him to be teaching natural history at a training center for retarded citizens. He and wife Pat had a wonderful family gathering for Christmas. . . . From **Bill Hurst** we have a letter reminiscing on undergraduate days when life was rather hard for many of us. Now Bill can look back on a career of accomplishments. He attributes much of his success to ingenuity and habits of logic acquired during his M.I.T. training. Bill was pleased to have a telephone call from **Phil Taylor** on New Year's Day and says they had a delightful conversation.

Speaking of the old days, **Tex Sandidge** tried to buy a stereo record of old M.I.T. songs while he was on campus at the 50th. The Coop had nothing to offer, and Tex has expressed surprise and disappointment. We have looked into the matter also and find that he is right — no recordings of M.I.T. songs are available! Suggestions have been made to the Alumni Office, and we hope that something can be done eventually. . . . We are glad that **Jim Donovan** was able to get copies of "1928 — The Last of the Great Years" mailed out to the Class. This delightful piece of historic (and for many of us, nostalgic) writing was done by Carol Joyce Davis, daughter of Marjorie and **Bill Bendz**. We hope you enjoyed reading it as much as we did.

We have news that two of our good classmates have won high honors in recognition of outstanding achievements in their respective fields of endeavor. On November 1, 1978, **Charles A. Southwick, Jr.** was inducted into the Packaging Hall of Fame at a dinner in Chicago given by the prestigious Packaging Education Foundation. Charlie's citation included a review of his accomplishments over many years as a researcher, consultant, and educator in the packaging field. To you, Charlie, our hearty congratulations on your well-earned honor! . . . A news release of October 18, 1978 by the American Society of Civil Engineers announced that **George Palo** had been awarded the Society's Rickey Medal at its annual convention in Chicago. George was given this high honor for "his outstanding service and contribution to the science of hydroelectric engineering." During his long career with the Tennessee Valley Authority George's management and technical responsibilities developed until his work on hydroelectric and steam-electric generating projects involved annual expenditures of over $200 million. The design and construction of T.V.A. nuclear power generating plants undertaken under George's guidance will finally involve capital expenditures in excess of $1 billion. To you, George, our great respect and congratulations!

As always, we are delighted to have correspondence from our class widows, all of whom are loyal daughters of M.I.T. and '28. Notes have been received from Ethel (Mrs. **Carl J.**) **Bernhardt**, Janet (Mrs. Edward) Sawyer (formerly Mrs. **John W. Chamberlain**), Judith (Mrs. **Benjamin F.**) **Miller**, Frances (Mrs. **Carl F.**) **Myers**, Mary (Mrs. **Arthur A.**) **Nichols** and Mary (Mrs. **John A.**) **Russell**. We should mention here that Ben Miller's book, *The Complete Medical Guide*, has been updated and published in a new edition by Simon and Shuster. Ben's work and fame are long enduring.

It is with deep regret that we must report the deaths of three more classmates. **Richard G. Buzby** died on October 17, 1978. Dick graduated in Course XVI (Aeronautical Engineering) and devoted his professional life to the aircraft industry, much of it with Cornell Aeronautical Laboratory, Buffalo, N.Y. In his later years he was business manager and treasurer of schools in his home town of Grand Island, N.Y. We talked with his wife, Anne, and extended to her and their two sons and daughter the sympathy of the class. . . . **William G. Kirk** died on January 10, 1979. After graduating in Course XV (Business and Engineering Administration), Bill went on to acquire his M.B.A. at Harvard Business School, then — following Navy service in World War II — studied law at Boston College and became a member of the Massachusetts and federal bars. For most of his business life Bill was president of the investment counsel firm of which he was a cofounder. Our sympahty has been expressed to his wife, Alice, and to their four sons and two daughters.

Irving H. Small (Course II — Mechanical Engineering) died on October 24, 1978. Prior to retirement Irving was production manager at Universal Joint Co., Springfield, Mass., where he had 30 years of service to his credit. Earlier he was an engineer for the city of Springfield. To his wife, Hazel, and to their family we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

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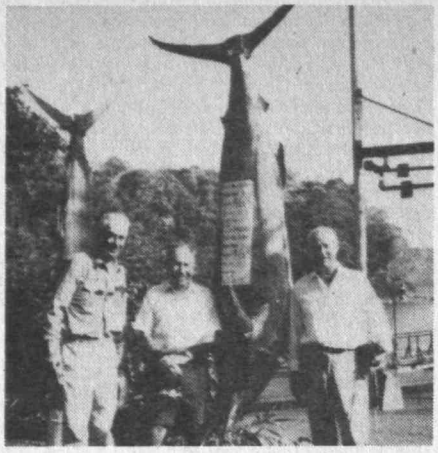
Most of you fellows, I am sure, would be thrilled to be invited to go deep sea fishing. How would you react if such an invitation was tendered to you with a week's trip to Pinas Bay, Panama, as well? Prof. **Walter H. Gale**, affectionately called "Wally," invited **Frank Mead**, chairman of the 50th Reunion committee and **Bill Baumrucker**, president of our class, to Panama as his guests for a week's deep sea fishing. Since the trio were scheduled to take a Pan Am flight from Miami International and mindful of his responsibility as a gift chairman, Frank arranged an earlier flight from Tampa to Ft. Lauderdale so as to be able to pay a visit to **Hugh Hamilton** with me and **Gus Stein** who also had agreed to accompany us. "All is well that ends well" fits the events that followed that Friday, January 19. Frank's plane was an hour late, and we arrived at the Hamilton's home too late for a scheduled luncheon arranged by Hugh's wife Helen at the Boca Raton Yacht Club. But the trip was not in vain; Hugh was glad to see us, and Frank took advantage of the opportunity and made his pitch for a generous 50th Reunion gift, which was favorably received. While we were sipping sweet sherry and munching on crackers and cheese as a substitute for the luncheon, Gus advised us to allow a little more time to meet Wally and Bill for the 4:30 p.m. flight to Panama.

Frank sent me a note upon his return about what a fabulous time they had. "Upon our arrival



Walter Gale, '29 (left) invited Frank Mead, 50th Reunion chairman, and Bill Baumrucker (right), class president, as his guests for a week's deep sea fishing in Panama. Their catch included a 467-pound blue fin and a 245-pound black marlin.

at Panama City Airport, we were picked up by *Tingo*, a vehicle owned by the Tropic State Lodge at Pinas Bay who took us to the La Siesta Hotel near the airport. Next morning, we arrived at the airport for a flight with 11 others to the lodge in the mountains by DC3, to a cow pasture landing strip near the Columbian border. From there we used dugout canoes to reach a 32-foot cruiser which took us to the lodge, comprised of small cottages. The one Wally had hired was called *El Palecio*. To get to it, one had to use a four-seat car pulled by an electric motor cable along the side of the mountain 150-feet high. Besides the beautiful scenery and fabulous meals, we went fishing almost every day and had something to show for it. Bill and Wally hooked a 467 pounder — blue fin, the biggest ever — and took an hour to pull it in. I got a black marlin weighing approximately 245 pounds, along with 30 dolphins (not porpoises). The occasion was celebrated at the lodge, where the captain and crews joined in."

Theodore S. Alexieff writes: "I just passed my 70th birthday and I don't feel any different. I am enjoying my retirement, doing gardening, reading, and moving around as the spirit calls. I enjoy reading the class notes, and your birthday greetings idea must elicit a great response." . . . A note from **Steven Dilworth** and his wife Myn states that they have joined the swelling ranks of '29ers who have made south Florida their permanent address. They have purchased a condominium (B332 Penthouse Greens, 225 Country Club Dr., Largo, Fla. 33541) and are very happy about it. They are planning to attend our 50th Reunion, and they will be celebrating their 5th wedding anniversary. Some of you may recall the romance between Steve and Myn beginning a few months prior to the 45th Reunion; everyone did his bit to convince Myn to say "yes." They were married shortly after their return home.

George Meyers, Jr. and his wife Barbara are well and keep active both physically and business wise. They play tennis several times a week, and have been active in their Church of Christ for many years. George teaches Sunday school and is a senior warden of the church, and Barbara is on the Altar Guild as well as Chairperson of the Christian Social Relations Committee. Their son Brad, a lieutenant commander in the U.S. Navy, is the father of a baby girl — Elizabeth Bowie Meyers — who was baptized on Thanksgiving Day in Christ Church. She wore the gown worn by George's mother, his aunt Catherine, his grandmother, and his great-grandmother — four generations.

I regret to announce the death of **John S. Saloma** who passed away on October 15, 1978, after open heart surgery. He was a native of Helsinki, Finland. He was associated with the consulting engineering firm of Charles T. Main Co. (Boston) and headed several power plant projects. Notable among them were the St. Lawrence Power Project and the Robert Moses Power Project at Niagra Falls.

I received a letter from **B. King Couper** with a generous 50th Reunion contribution enclosed. He lives in Tyron, N.C., where the climate is gentle except for the excessive summer heat and humidity of the South. In June, 1978, he attended the 75th anniversary of Scripps Institute of Oceanography at LaJola, Calif., where he received his master's degree in 1948. In July, he attended the Scots Games in the Grandmother Mountain and steeple chases in Tryon. He says he just watched the games; he did not participate in the events. His most recent achievement is a ham radio license. His call letters are: KA4A0Z on 40 meters. As a Rotarian, he meets a large number of formerly big executives who have chosen to retire in Tryon. King attended the 40th Reunion and he will be with us at the 50th Reunion next June at Chatham Bars Inn.

John D. McCaskey is well and studying hard for his doctorate degree. He will join us for the Big Reunion at the Cape next June. . . . A note from **William F. Jenkins** reads: "I received my B.S. degree in electrical engineering from Rice Institute (now Rice University) in 1928. We had our 50th Reunion here last month. My three roommates and their wives came in for the occasion, and my wife Patti and I had them for our house guests. It was the most enjoyable three days that I have had, and I guess my former roommates and their wives felt the same way. Here is something to think about — of all the roommates (five in all) that I have had, all of them wore shoes that fit me. So, occasionally, I used to borrow their shoes."

Gordon R. Williams says: "I theoretically retired in July, 1976, as an associate and chief hydrologist for the firm of Tippetts, Abbett, McCarthy and Stratton, Consulting Engineers of New York, but I am as busy as ever doing consulting and worldwide business traveling for the same firm. I was supposed to be superceded in my field by computers, but the Ph.D.'s can not "debug" the programs; they understand the solutions but not the basic problems. My wife Olive and I have been planning for the past two years to return to New England to be nearer our children and grandchildren. But we cannot find anything as comfortable as we have. When one moves on the East Coast, he substitutes one type of congestion for another."

By the time you read these notes, it will be about two months before we gather at Chatham Bars Inn for a history making event, sending our 50th Reunion date into eternity. With this thought in mind I would like to ask each one of you two things: come to the reunion if you can possibly make it, and please make your pledge or contribution to our class gift as generous as you can afford. **Frank Mead**, our gifts chairman, confided to me when I saw him in August that his goal is to reach the sum of $1,000,000 for the class gift, and we are very close to it. With your help we will achieve our objective. Thank you and God bless all of you. — **Karnig S. Dinjian**, Secretary, 6000 N. Ocean Blvd. Apt. 14-E, Ft. Lauderdale, Fla. 33308 (305) 946-0425

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Significant numbers of the Alumni Fund envelopes are now beginning to come in, and we have several very brief items from this source. As previously reported, **J. Palmer Boggs** retired as Professor of Architecture at the University of Arkansas in 1976 but continued to do some consulting work. It appears that he is still doing a certain amount of consulting work but is "more and more retiring." . . . **Hal Spaans** is largely retired but still "doing a stint of teaching twice a year for United Telecommunications System." . . . **Bart DeLorenzo** remains active as president of Barth Engineering Co., Inc. He lives alone (Lafayette, Calif.) with a small black and white dog and plays golf when he can. He reports that "today's golfballs are less lively than they were a few years ago and getting deader every year."

Ed Huson is "still extremely busy and quite healthy at 72 years." . . . **Bill Wye** recently saw **Jim George** who was headed for Texas for a hip operation and Fran and **Tom O'Connor** in Boston who were about to embark on a trip to the Caribbean. It appears that Bill has shifted his field of interest from the stock market to the commodities market but that his ventures in the latter area have not been entirely successful. . . . **Sig Linderoth** is Professor Emeritus of Mechanical Engineering at Duke University, and he and Doris are living in Pinehurst. Since his retirement he has been carrying on a limited consulting practice in the field of environmental pressure effects on the physiology of human beings. He helped design the Hall Laboratory for Environmental Research at Duke Medical Center and has been active in research on the effects of extremely high pressures (1600 psi) and low temperatures (28°F.) on deep sea divers. At the time of writing he was doing a project for the Naval Medical Research Institute at Bethesda, Md.

Ralph Peters, who is a member of the International Executive Service Corps, has forwarded the information that fellow member **Wes Wedemeyer** has gone to Bucaramanga, Colombia, as an advisor to Urbanizadora David Puyana S.A. . . . As previously reported, Lucille and **Paul Kimberlin** have selected Pearce, Ariz., as their retirement home. Their retirement activities include recreational vehicle trailer traveling, fishing for black bass in Mexico, caring for their collection of cacti and other desert-type plants, and hoeing the weeds in the front yard. Paul reports having recently seen **Bob Lytle** who is living in Grosse Point Park, Mich., and spends some time working with his son Bob Lytle, Jr., who is also an M.I.T. graduate.

Sven N. Lindhard retired about ten years ago after a stroke from F. L. Smidth and Co., designers and manufacturers of cement plants and cement-making equipment, grinding mills, and rotary kilns. He was a special process engineer and designer of rotary kilns and their application to various processes. He is living in Fair Haven, N.J., and lists his activities as fishing and boating. . . . **Bob Nelson**, who lives in Glendale, Calif., reports having recently seen a number of other classmates. These contacts included a visit with Betty and **Ed Kingsley** at their winter home in Mesa, Ariz., as well as meetings with Louise and **George Perry** and Dottie and **Tom Wigglesworth** in Glendale. It appears that George is interested in bird watching and usually carries some very sophisticated telescopic and camera equipment with him. Ed, Bob and Tom are all tennis players but Tom has a heel problem at the moment that will interfere with his tennis playing for a time.

We have at hand reports concerning the deaths of three more of our classmates: **Mark Purcell** on October 8, 1978; **Nathaniel Rand** on November 7, 1978; and **James Pickell** on November 18, 1978. According to my records which may well be out of date, Mark and his wife Catherine lived in Madison, Wis., where he practiced architecture with the firm of Siberz, Purcell and Cuthbert. The Purcell's son Philip is associated with a Chicago law firm. Mark was a member of the Governor's Committee on the State Capitol Building and Executive Residence in Madison, as well as chairman of the Building Board of Appeals, a director of the Wisconsin Chapter of the American Institute of Architects, and a trustee of the committee to preserve restored buildings in Madison.

My records indicate that James Pickell practiced architecture in Nashville, Tenn., and in 1964 he and his wife Mary retired to Naples, Fla., where he was apparently living at the time of his death.

The information about Nat Rand comes via a letter from **Bill Waite**. According to Bill, Nat's home was in Newark, Del., but he died in California, perhaps while visiting there. He and Bill worked together in the du Pont engineering department, specifically the Louviers Building in Wilmington. Nat was a design engineer in the design division when he retired in June, 1969, with over 18 years of company service. He is survived

by his wife Dorothy, one son, and one daughter. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

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Howard B. Huntress says that all his children are married now and that he has 2.5 grandchildren. Last July he had a mini-reunion with Peg and **Bill Bachli** and Margaret and **Al Ziegler**. Now he is very busy in retirement, working and singing. . . . **Ed Goodman** reported that he has retired after 41 years with Sprague Electric. He still lives in Williamstown and spends about eight months a year there. He claims that camping, tennis, skiing, and a bit of travel keep Jane and him fit. Both he and Jane say they would love to see any classmates or friends who are ever in their neighborhood in the Berkshires. . . . The only news from **Ed Norris** is that he objects to the wine ad in the *Technology Review* unless advertising dollars are getting hard to come by. (Note: Since I enjoy wine with my meals, I can't agree with Ed.)

Ben Mesick writes that his daughter is at the American Embassy in Caracas, Venezuela, and the he and his wife expect to visit her there in February, 1979. . . . During our weekly ham radio schedule with **Fred Elser** in the Hawaiian Islands, he told me that Mardy and he just celebrated their 47th wedding anniversary. Congratulations to you both. . . . **Charles Gilmour** has been the recipient of the Don Q. Kern Heat Transfer Award for 1977. . . . Although retired for some time, **Jack Lane** continues work as a consultant for Compagnie Francaise de Raffinage. (By this time his French should be pretty good!) Jack says it gives him an opportunity to maintain contacts in the petroleum and automotive industries as well as with the technical and trade groups in U.S. and France. . . . **Horace Ford, Jr.** reports that he is a member of the Cruising Club of America and chairman of the Race Committee of the St. Lucie Sailing Club.

Sam Janney says that he is still enjoying retirement and building model engines. . . . Word from **John Hutchins** tells that he retired from teaching and research in the Graduate School of Business and Public Administration at Cornell in 1975. After that, he had to have a knee operation. John and his wife have made a round-the-world cruise since then and several trips to Florida. (If you are ever near Mount Dora, John, Please stop in. — Ed.) John is staying close to Cornell, but in the summer he enjoys his Maine home and the 42-foot yawl for cruising. Their Maine home is near to their even dozen grandchildren. . . . **Emile Grenier** is continuing his fight against the airbag and now has applied for a patent on the airbag as a human execution device. According to the patent application, an airbag inflated directly under the subject's head would exert a force of 12,000 pounds, snapping the neck "far more effectively than the hangman's noose with an action so instantaneous as to preclude any pain."

Christmas cards from the following classmates tell that they are planning to attend the mini-reunion in April: Hope and **Randy Binner**, Jean and **Claude Machen**, Evelyn and **Howard Richardson**, and Ella and **Emile Grenier**. It will certainly be good to see them again.

Louise and **John Swanton**'s Christmas letter was most interesting, written from their son's yacht in the Bahamas to tell of their travels during 1978. John and Louise covered much of Europe including Czechoslovakia and Poland as well as Ireland. Unfortunately, lack of space precludes including the entire letter in these notes as it would be of interest to all the classmates.

Emile Grenier has sent me a note and several clippings telling of **Herb Chandler**'s death last August. Herb was Emile's best man years ago in Buffalo, and they wrote their thesis together at M.I.T., receiving an "H," one of the many Herb received there. Herb retired a little over two years ago as director of engineering for the Navy and Air Force at the Westinghouse Air-Arm Division plant at Baltimore-Washington International Airport. He had first come to the Baltimore area in 1949 to take a similar post for the Navy at the Glenn L. Martin Co. He was a member of the first aeronautical engineering class at M.I.T. and graduated first in the class.

Word has also been received of the deaths of **Raymond Donway** on December 11, 1978, and **Donald Herbert** on September 12, 1978. Our deepest sympathy to their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; **Ben Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, Mass. 02360; and **John R. Swanton**, Assistant Secretary, 27 George St., Newton, Mass. 02158

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Mail this month was quite voluminous, and I have enough material for two issues. I note that many of us play golf, so I would like to announce a golf tournament for the Class of 1932 in which all of us can participate. It will be held in the month of July. Wherever you are, play a round of golf on a regulation 18-hole golf course. Have your score card signed by a witness (either a partner or opponent). On any given hole do not take more than a triple bogey (on a par 4 hole, 7 is maximum). Then, mail your results to me before August 15, 1979, and indicate your official handicap.

A committee consisting of **Donald Brookfield**, **William Pearce** and I, plus any other volunteers, will meet and award prizes on a gross and net basis. If 25 classmates participate, we'll call the tournament a success; if less than 12 respond, we'll call it a fizzle.

L. William Glowa writes that he is working full time. He provides liaison with the directors of research of 91 corporations and the Department of Defense and keeps the government informed concerning the independent research and development work of these corporations so that the state-of-the-art technology is available to the Defense Department. . . . **Edwin H. McCormick** writes that he came out of retirement to become Chief Chemist and Supervisor of Water and Wastewater Systems on Jekyll Island, Ga. After prescribed schooling and 15 examinations, he now holds Georgia Class I Wastewater and Class II Groundwater certifications. Well, Ed, it's never too late to learn; good luck on your new duties. . . . **Kenneth W. Smith** is retired and enjoying it. He is active in community affairs such as Kiwanis Club and Meals-on-Wheels. He plays golf several times a week. He plans to be at Indian Rock Beach, Fla., from January to April where he hopes to look up old friends and fraternity brothers.

R. S. Huested is now retired. His daughter Sally and son-in-law Charles Oman are pursuing the academic life. She is doing graduate work in undersea chemistry, and he is an associate professor at M.I.T. in aeronautics and astronautics.

We receive the sad news that **Donald A. Rice** died of cancer on October 24, 1978, at the Anne Arundel General Hospital in Annapolis. He retired in 1974 after 42 years of federal government service. He started as a mathematician with the Army Corps of Engineers, transferred in 1942 to the U.S. Coast and Geodetic Survey and was made a branch chief in 1950. In recognition of his contributions to geodetic science, Donald received many government honors and medals. He wrote numerous scientific papers and held office in many technical and scientific organizations. He is survived by his wife, the former Anne Sieman Machen and three sons — Ronald, Richard, and John. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

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Most of this issue's news comes from a nice source — Christmas cards! Louise and **Ellery Clark**'s card told of a trip to Europe after the Reunion; they returned home via Canadian transcontinental train, then to Southern California via bus. They are going to take a Queen Elizabeth II trip in March: Los Angeles round trip to Port Everglades, Fla. . . . Charalee and **Dick Fossett** took a notably different trip to the New Zealand South Island, and did some hiking in the Milford and Mt. Cook areas. The weather left something to be desired but the world-famous scenery covered that up. . . . **Westy Westaway** sent best wishes. . . . Eileen and **Dick Smith**, 40 miles away at Key Biscayne, wish that we had a reunion at Chatham Bars Inn every year. After the 45th, they spent five days at M.I.T.'s Ashdown House, and took many local trips on a genealogy hunt.

Jeanette, Heidi and **Werner Bachli** sent their kind wishes for our personal health but regretted a shortage of news. Col. **C. P. Newton** and Fran noted that there were five Melrose High School classmates who attended the Reunion: **Art Hayden**, **Bud Lobdell**, **Roland Glenn**, **Bill Soley**, and the Colonel himself. . . . **Bill Baur**'s card is perforce a mirror of his personal situation — his loss of the lovely Claire — and he commands us to be careful and stay well. Edna and **Jim Turner**'s card was lovely and reassuring. . . . We received a card from **Meredith Morgan** which we do appreciate. . . . And here's one from **Walt Skees**. The irrepressible Walt says thst he wishes to sell his holdings in the Bahamas. If any friends of Walt are interested, I will Xerox his list of holdings and mail it.

Leon Hyzen writes his wish that I recover from an illness, and that I be as strong as my old Angus bulls — too much, Leon, but thanks. . . . **Cal Mohr** reports on a **Walt Swanton** Christmas letter, in which Walt says that his house was designed by Claude Bragdon, a very famous architect around Rochester, N.Y.; Walt is doing a rather extensive research job on Bragdon. Walt is also making a study of economics based on a chemical engineering approach — he would welcome inquiries from anyone interested. Cal never sends anything about himself, but does help a whole lot.

Len Julian reports that he had chest pains which got him into the intensive care unit, but was given a clean bill of health. Len thinks that many of our classmates who attended the 45th have mellowed enough to have shed their inhibitions as presidents and chairmen of the boards, and have become, socially, like us lesser lights. I, too, noticed such a change. . . . Lucy and **George Henning** sent an unusual Christmas montage of family photos. . . . Now for the **Jack Frost Andrews**' effort! Though not so long, their letter is warm, just like themselves. I do hope that all you who attended the 45th took the chance to visit with this truly great couple.

We have a short one from Dr. **Bill Harper**: he read about **Al Moeller** and his escapades through the years, and he asks if Al was the one who took off a slice of the cylinder heads of his big motorcycle so as to soup up the power through added pressure. I don't remember that one, but I seem to recall **Jack Williams** doing the same thing on a shaper, on the cylinder head of automobile engine, with which he was racing at Readville, Mass.

The Alumni Fund Capsules are far more numerous than usual this time around. First of all, and surely the most welcome, is a message from **Dick Morse**, who announces that he retired from the Sloan School last year, but is serving as a director with several high-technology companies — mostly in Boston but with one located in Dallas. Marion and he have just returned from a great trip in the Black Sea area. . . . Joe Goodman comes through with an interesting message: After the 45th, they spent another week on the Cape, visisted Henry Thoreau's cottage at Wellfleet, and met Rose Kennedy at Hyannisport; a Grand Old Lady! Later he visited science museums in Boston and Chicago, and one other, the Fermilab Research Center. . . . Once every five years I get a fine note from **Frank Vanucci**. He retired in 1976 after 43 years with Owens Corning Fiberglass. Son Peter is vice president in commercial loans with the Women's Federal, Cleveland. Daughter Elaine is unmarried and is a registered x-ray technician at Children's Hospital, Columbus, Ohio. . . . A real nice one form **Warren Daniels**, who missed the 45th on account of being tied up with his new business, Travel Agent. He and Dorothy spent last Thanksgiving in Yucatan, seeing the Mayan Ruins, and the beaches at Cozumel,

where I have been myself. . . . We have an exceptional note from **Emmy Norris**: "Emerson and Christine celebrated their 40th wedding anniversary October 1. On the same date, their sixth grandchild was born, but the first Norris grandchild, Todd Shipleigh, is the only Norris descendant of his generation in the Emerson family line. M.I.T. 1996? If so, he will follow his grandfather, his great-grandfather, an uncle, and two great-uncles."

Bill Pleasants writes that he retired from his position as acting county engineer, Sussex County, Del., and is now employed as project manager for Diamond State Engineering in Dover, Del. The projects are for the Dover Air Force Base, Port of Wilmington. . . . **Frank Gilmore** has really moved into the Cape. He is president of the Cape Cod M.I.T. Club, member of the Alumni Council, and junior warden of St. Mary's Church, Episcopal; and he sailed his boat from the Cape to the Florida Keys, via the Intracoastal — right by my house in Hillsboro Beach, though the dock won't float a row boat. . . . **Fred Walker** writes from Denver that he is retired since 1971, so has plenty of time for his gardening activities and visiting with friends. However, with heart and stomach troubles, his activities are restricted.

Through **Carl Swanson** we find that **Werner Rose** passed away in 1977. I wrote Mrs. Rose the usual class condolences, and she wrote me a lovely note of Werner's passing. . . . Evelyn Johnson also wrote me thanking me for my note of sympathy for the class, confirming that Theron had, in fact, passed on, as was noted in the December column. . . . Alumni Records have notified me that Dr. **Basil W. Parker** passed away, August, 1978. There are no details.

That's it for this time around — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

34

The end of the year always brings forth a considerable number of Alumni Fund notes and this year was no exception. In fact, there were so many that I'm holding some over for the next issue. For the most part, you will see that more and more of us are retired, or have been for some time.

Warren Towle has just joined our ranks; he says, "I retired in April, 1978, and am building a winter home in Santa Fe, N.M. I should be in it by January." Less specific in time is **Hal Bellinson**, who just notes "retired and enjoying it." . . . **Gil Lorenz** writes: "While Thelma and I were on a trip to Alaska and the Canadian Rockies this summer, we ran into **Dick Sanders** and his wife in the Red Dog Saloon in Juneau. We enjoyed renewing friendships over a beer. In October Thelma and I had a very interesting tour of Egypt, Tunisia, and Morocco."

Bill Ball comments: "Lois and I are still looking for a retirement house on Cape Cod or in a shoreline town east of New Haven in Connecticut. We're looking forward to our 45th Reunion next June." I knew Bill was looking around here; unfortunately, I missed him by about 25 minutes on one visit. It turned out the real estate man he was working with goes to the same church I do and stopped by with Bill on the way to the airport. That turned out to be one time that both Jane and I were out. . . . **George Hatch** sends word: "My wife and I are in very good health and are thoroughly enjoying my retirement. We are busy with the San Diego Opera and other committee work, gardening (especially growing orchids outdoors), and traveling." . . . **Ruth Pfeiffer MacFarland** writes: "My husband and I are planning to move to Union, Conn., next year. He is also an alumnus, M.S., 1934 in mechanical engineering." . . . **John Delmonte** says: "I am a consultant for Delsin Testing Lab, Glendale, Calif., and for eight grandchildren (ages 1 to 15)." I wouldn't even bother to ask which is the tougher of the two. As the books used to say, "The solution will be obvious to the student."

Unfortunately, I have a loss to report — that of **Henry C. Miller, Jr.** His widow Carol was good enough to send some information; she says: "Henry died at home after a long illness on November 10. We moved from Cincinnati to Chapel Hill in 1969. Henry worked with the Environmental Protection Agency at the N.C. Research Triangle Park as Chief of the Office of Fuel and Fuel Additive Registration until his retirement in 1976." In addition to his wife, Henry is survived by two sons (Henry C. Miller III of Washington, D.C., and Cyrus Miller of Cincinnati) and a sister (Janet Bernet of Charlottesville, Va.) To all the family I would offer from all of us our sincere condolences.

You will remember that about a year ago we reported on Rev. **Joseph A. Hahn** who is concerned with publication work at the Maryknoll Catholic Foreign Mission Society. **George Bull** has passed on another letter from him outlining his continued activities. Rev. Hahn is still Marketing Director and Production Manager. Also, since winning prizes as a photographer, in the last year he has been on photo missions to Tanzania, Zanzibar, Israel, and Nicaragua. To keep from getting rusty, he expected to leave in January for Brazil, Chile, Peru, and Bolivia. He concludes that he hopes to make it to the reunion, the month he will be celebrating his 37th anniversary in the priesthood. Incidentally, George himself notes that whether he can come or not depends on the timing of a trip he and Mary Elizabeth hope to make to China.

The reunion theme seems to be a good one on which to conclude. You will all have seen the program that has been arranged by the time you read this. We think it's a good one and we are having an excellent response. If you are still wavering — fall over on the *YES* side. — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, Md. 20015

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I am pleased to pass along to you a nice letter from **Les Brooks**: "As the year ends I'm looking forward to retiring sometime after May, 1979, when I'll be 65. Having been cold all my life, we're heading for warmer climates and have a spot picked out just outside Little Rock, Ark., on the north side of Lake Maumelle. If our good health persists, we plan a lot of outdoor activities. Because I had a slight mishap a few weeks ago, namely a broken ankle, we missed our usual late November jaunt to the Carribbean. Our favorite destination now is the secluded, delightful little Villa Cofresi at Rincon, P.R., where the world surfing championships were held in 1969. Last year we were pleasantly surprised to see and talk with Dr. Luis A. Ferre '24, who was conducting a two-day seminar at the Villa on political education for young folks. You will recall he spoke at our 40th reunion. P.S. I did *not* mention the ankle just so I could get a higher golf handicap."

While Puerto Rico is on my mind, I'll mention that Doreen and I celebrated our 25th anniversary staying at Palmas del Mar, Humacao for five days in early December. It was our first visit to Puerto Rico and we were intrigued with its tropical climate and vegetation. We felt worlds away from wintry New England and came back with lovely tans that disappeared in days.

Adela and **Earl Peterson** fled Austin, Texas, for a relaxing vacation in Acapulco and sent a card telling us how great the Pacific beaches were for swimming.

The following notes were received through the Alumni Fund Office. **Bob Landis** writes, "Rita and I had a better than average summer at our small house along the St. Lawrence River near Ogdensburg. We would like to attend a June activity at M.I.T. but again had a schedule conflict. Now preparing to spend the winter in Manchester, Conn." . . . From **Art Haskins** comes this note: "Officially retired from Bath Iron Works. Fully employed as a consultant by Bath Iron Works in essentially the same capacity, chief estimator. Expect to be able to spend more time boating next summer — at least working for yourself is supposed to allow that kind of independence." . . . **William W. Seary** writes this quickie: "Retired twice! The Budd Co. and Boeing Vertol Co." Bill, we hope to receive a substantial expansion of that for the next notes. . . . A note from **Sam Brown** reads, "The present good news is that on January 7th, 1979, Mrs. Natalie Earl Humphrey and I will be married. We shall have a shared flock of 7 children and 15 grandchildren." Much happiness to the newlyweds from all of us. . . . **Nelson H. Thorp** sent this compact message: "Merle and I were able to take a trip around the world this past winter on the *Sogafjord*. One of the highlights was a three-day trip into the People's Republic of China which was very revealing." I think this calls for more detail, too! . . . **Philip H. Rhodes** covers about everything in this note from Cincinnati: "Still having fun managing a small company in PVC coated and laminated fabrics, cast film, etc. Phil Jr. is a program manager at Bell Helicopter and Phil III is managing a school in Tokyo after an M.B.A. in Japan on an exchange program. Other grandson, Henry, is in third year at the University of Texas in Dallas. We celebrate our 46th wedding anniversary this year."

Early in November, '78, the younger of our twin sons, Christopher, was married to Kay Garefino in Lambertville, N.J. They are living in Watertown, Mass., and Chris works at Theta-J Corp. as a Group Leader. I became chairman of the board at Theta-J last fall. Apparently, the 10-to-12-hour days and six-day weeks aren't shortening my life. At my last checkup a week ago, my doctor said I was one of those who would never reach his chronological age, that I was pathologically under 50! And I must say I feel great. I am a very fortunate man. What's new with you? — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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Sadly I report the death on December seventh of **Frederick H. Carten**, Course V, who went on to earn a Ph.D. in chemistry. His brother Leo, '34, writes that Fred, who died of brain cancer in Boca Raton, Fla. (his residence since retirement in 1972), had served in a leading capacity in the Research and Development Directorate of the U.S. Army Material Command Headquarters. He was active in Boca Raton civic affairs and was chairman of the Salvation Army, running their campaigns and looking after the day-to-day cases requiring assistance. . . . Abe Rockwood '40 has also written to tell me of the sudden death of his neighbor and our classmate, **Richard Harrington** in Needham, Mass., on January 10. Rockwood writes: "Dick had retired recently and even then found he didn't have time to do all the things he wanted to do but enjoyed his well-earned leisure." Harrington, Course IV, is survived by his wife, two sons, a brother, and a grandson. During World War II he served in the Navy as a Sea Bee. To his family and Abe Rockwood the class extends sympathy. . . . I have also been informed without details of the death of **Richard O. Lane**, a graduate member, on October 11, 1978, in Michigan. The *Alumni Register* lists him as Marketing Director of Frank Bancroft Corp. in Dearborn, Mich. He could have been retired.

Class President **Tony Hittl** wrote to report the death last November of the wife of **Charles Saffer** after a long illness. Our sympathy goes to Charlie who helped us plan our 40th, even though he was unable to participate. . . . Recently I received a note from **Tom Kato** in Tokyo, and when I opened the envelope I was surprised to find the letterhead of the State of New York, Department of Commerce, Tokyo Office. Tom reports that he is now employed by the Empire State in the office which is "primarily concerned with furthering investment of Japanese manufacturing interests in the State of New York. We are more or less a coordinator, and although I've just become associated with this office I find the work very interesting and a good challenge. Needless for me to point out, I left the other outfit about a year and a half ago and am now back in the grind at the ripe old age of 65. Mentally and physically I'm in real good condition,

so, like my predecessor — also an M.I.T. alumnus who retired at 75 — I believe I have many many more years of productive work to do." Those of you who saw the handsome snapshot of Tom which I had at our fortieth will realize that he writes accurately, and we all join in wishing him well in his new position.

Vernon Osgood writes that he retired from Du Pont on December 31 after 41 years. He and Charlotte will stay in Orange, Tex., where they have lived for 31 years. . . . **John Myers** is enjoying semiretirement in Redwood City, Calif. He does some financial consulting and income tax work when he is not working on the cars, the house, or the yard. . . . **Rufus Isaacs** retired over a year ago and is Professor Emeritus at John Hopkins. The January, 1979, issue of the *Journal of Optimization Theory and Applications* was dedicated to him. Details of his career and accomplishments are included in that *Journal*. I hope that some classmate who sees that issue will send me a copy of the material! . . . **Albert Del Favero** is semiretired from the Oman Construction Co. of Nashville, Tenn., and is making his residence at 914 West Ashworth Place, Glendora, Calif. 91740.

Raymond J. Woodrow retired in June, 1978; he had been senior university officer at Princeton. His book, *Management of Research in U.S. Universities*, was published in the spring of 1978. . . . **Al Bagnulo** writes that after deciding to retire for the fourth time he changed his mind and is now working part time for Greeley and Hansen, Engineers. He is involved in planning studies for expanding and upgrading wastewater treatment plants and can do most of the work at home at his own pace. . . . **Bill Kennedy** reports that in March, 1978, he and his wife Bea visited India and Nepal with a Pacificulture-Asia Museum Group. Bill played golf in New Delhi, Jaipur, Kashmir and Kathmandu! Home for the Kennedys has been within commuting of Burbank, Calif.

J. Ross McKeever, who has been a city planning consultant, reports simply, "Retired." Whether he is still in the Washington area is anyone's guess.

Current news has taken up the space for this issue. I still have some news to report from the replies received last fall and will pass it on next time. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

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If each of you in 1938 would follow **Don Severance**'s example, my job would be a lot easier and you would get more class news each month. Don, who is my most faithful and prolific assistant secretary, passed on the word that **Raffie Sanchez** is still in Miami, working for Rinker Material Co., producers of cement and other construction materials. His current assignment, responsive to energy conservation, is converting one of their plants from oil back to coal. . . . **Cornie Roosevelt** was recently elected a trustee of the nonprofit Aerospace Corp. He is presently a technical consultant to governmental agencies and to private industry. . . . Another election: **Lou Heaton** was named Senior Vice President of the New Hampshire Insurance Co., a member of the American International Group. Lou presently resides in Amherset, N.H.

Bill Guindon writes that, as prexy of the Jesuit School of Theology in Chicago, he attended the founding meeting of the Council of Catholic Theological Institutions in Porto Alegre, Brazil. . . . **Bill Whitmore** concluded a seven-year term on the M.I.T. Visiting Committee for the Department of Mathematics. He and **D. Jelatis** participated in the M.I.T. Sea Grant Collegium meetings. . . . Word was received that Dr. **Ely Mencher** passed away last December. No further details are available. — **A. L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, Mass. 02633

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Seymour Sheinkopf is chairman of the 40th Reunion of our classmates. He reports 59 classmates signed before February to attend. They include: **Bill Brewster, Eli Dannenberg, Seymour Sheinkopf, Ernie Kaswell, Aaron White, Fred Schaller, Hal Seykota, Ryder Pratt, Mark Curgan, Manning Morrill, George Cremer, Leo Kiley, Arthur Zeldin, Will Jamison, John Hamilton, Robert Thompson, Peter Bernays, Paul Stanton, Roy Haworth, George Pfaff, Thomas Leps, Robert Casselman, Sam Sensiper, Bill Willard, Bill Pulver, Charles Friedman, Irving Peskoe, Dick Guthrie, Harold Muckley, Mike Herasimchuk, Fred Beale, Charles Mercer, John Renshaw, Wiley Corl, Bill Wingard, Nick Carr, Elmer DeTiere, Harold Chestnut, Joe Mazur, Sol Baker, George Dadakis, Monarch Cutler, Lawrence Perkins, George Beesley, Akim Zaburunov, Hans Bebie, Burns Magruder, Lawrie Fabens, Ralph Hegner, Gus Hunicke, Arthur Olson, Earp Jennings, Vahey Kupelian, Bill Murphy, Joseph Neuendorffer, Dan Rex** and **William Phillips**. Fifty-five spouses will accompany; therefore the minimum attendance for our reunion will be 114 people.

Twenty-three other classmates could not commit before February, but are hoping to attend. They include **James A. Smith, Burton Rudnick, Frances Wypler, Arthur Grossman, Lawrence Lyons, Paul Gordon, John Dodge, Arthur Quint, George Cannon, Ronaldson Smith, Max Coutts, Harry Tileston, James Howland, Julius Lucas, Donald Timbie, John Allen, Anne Zemansky, Jim Ferry, Thomas Langs, Herman Hanson, Roy Hammond, Louis Smullin, Robert Schmucker, Earl Reynolds, Allen Velho, Fred Lehman, Leonard Mautner**.

Our reunion committee includes **Seymour Sheinkopf**, Chairman, **Ernie Kaswell**, Class President, **Fred Schaller, Aaron White, Manning Morrill** and volunteers. These classmates have done a splendid job to have accomplished so much so early in the project. To send your $15, or to volunteer to help, or to get more information, please write or call Seymour Sheinkopf, 205 Wolcott Rd., Chestnut Hill, Mass. 02167 (617) 731-9163.

James Bruce, '39

James Bruce, formerly Director of Public Relations for Eastman Kodak Co., has been named Senior Vice President of the Company. . . . **Holden Withington** is Vice President of Engineering for Boeing Commercial and he will manage engineering on two new airliners. The Seattle Times reported Holden's group will increase in size from 9,000 to more than 11,500 during the next few months. Holden and Betsy hope to attend the reunion, either before or after the Paris Air Show.

Eli Dannenberg finished a tennis match and stopped nearby at Falmouth Sports Center next-door to the Market Bookshop where, coincidentally, **Bob Casselman** and Dotie were visiting with fans and autographing copies of Bob's new book, *Continuum*. I have Bob's book and certainly recommend it. Here is an excerpt from the flyleaf: ". . . *Continuum* is an uncommon book dealing with an increasingly common problem: the ability to believe in the existence of God. It is the story of 20 years of searching by a man who wanted to believe in a God and a hereafter but couldn't — until he had picked his way by himself through the maze of the mind and the riddles of the universe. . . "

Leonard Mautner and Alix have lived for 18 years in the Brentwood suburb of Los Angeles. Twice before their home was threatened by

Beyond Science into a World Continuum

When Robert C. Casselman, '39, left M.I.T. with his bachelor's degree, he shared with his classmates a confident view of "an exceedingly ordered world, one that can be counted on to reveal its truths to a diligent searcher."

But as his life unfolded, Mr. Casselman found that not all truths revealed themselves. Even in the heat of war, he recalls "bewilderment over the paradox of a kindly, protective, omniscient supreme being permitting young men by the thousands to be killed . . ." He learned of many people "in communication with the dead," and he became intrigued and mystified by such phenomena as mind-reading, dowsing, and flying saucers. Even the basic questions of how thought and memory work could not be answered by science.

He finally concluded, Mr. Casselman writes in *Continuum* (New York: Richard Marek Publishers, 1978, $9.95), that he could not bury his doubts about psychic happenings: a "long list of paranormal phenomena . . . must be dealt with."

His efforts to deal with these is Mr. Casselman's subject in *Continuum*. (He is now Associate Director (in charge of administration) of the Museum of Fine Arts, Boston.)

His conclusion: "The psychic powers of human beings reside not in brain tissue, not in strange molecules as yet undiscovered in the cells of the brain, but in a wholly separate part of ourselves — the bioplasma." This represents a new form of energy embodied in the stuff of which humans are made, just as energy is embodied in the masses of atoms which surround us; it is the soul.

"Soul is us — our minds, our personalities, our memories, our thoughts and hopes and dreams. It is all we are, and it is all embraced in our inner energy selves, in our second bodies that must someday leave our wearying forms and move through the veil, to eternity."

With this understanding of a life within and beyond life, says Mr. Casselman, he faces the world confident that he can deal comfortably with the hard questions of why and how for which science alone is not enough. — *J.M.*

massive brush fires fanned by high winds. Last October a third fire threatened. The *Los Angeles Times* published a two-column article about the Mautners and reported Alix had arranged room in their jam-packed station wagon for Piper, their dog, but she had a problem with their harpsichord. The two-column newspaper picture shows Leonard carrying a washbasket full of small stuff toward the station wagon. The Mautners returned the next day to find house and belongings intact.

Roy Haworth is President of Plow-coa, Inc., a company he started 10 years ago to manufacture tungsten-carbide tipped wear parts. . . . **Al Velho** completed another tour of duty in South America and accepted new assignment in New York as Divisional Vice President of Plants and Production for Sterling Drug International Corp. . . . **Ernest Ohsol** completed three years in the Munich area of Germany and returned to U.S.A. to join C. H. Dexter in the paper industry. While abroad Ernest married Barbara Handy of Westfield, N.J., making her an "instant grandmother" of six.

Dick Cella was commended again — this time in the December 25 *Forbes* magazine which reports Dick as having one of New York's very best restaurants. By now Dick's trophy case must be overflowing with commendations plaques. . . . **Max Coutts** lives in Canada where he has served M.I.T. on its Educational Council and as local M.I.T. Club Officer since 1947. Until January 1978 Max was Director of Manufacturing for Honeywell Ltd. which employs about 3,000 people who make products selling for $100 million per year. . . . **Bill Willard** received a letter from **Tomas de Los Reyes** who lives in the Philippines. The de Los Reyes will join the Willards to attend 40th Reunion. . . . **Julius Lucas** retired from the Goodyear Tire and Rubber Co. after almost 40 years of service.

Leo Kiley retired from General Electric Co. and moved from Florida to New Mexico. . . . **Albert Ackoff** was honored by the Pioneer Award from the American Society for Engineering Education for his activities with the Continuing Engineering Studies Division. . . . **John Dodge** convalesced after two cataract operations, slowed down enough to retire, and now divides his time between boating and consulting. . . . **William Love** is the founder and President Emeritus of the International Association of Jazz Records, and he is producer of Jazum Records. . . . **Bob Touzalin** and Aletta continue to enjoy swimming, golfing, and socializing in Florida. They expect a visit soon from neighbor **Wiley Corl**. We hope Wiley convinces Bob and Aletta to come to Reunion before they start a long-planned European tour.

M. L. Keith, Professor of Geochemistry at Penn State University, retired after 28 years on the faculty. Dr. Keith's contributions included synthesizing silica-free synthetic garnets and publishing more than 40 articles in scientific journals. . . . **Bob Pratt** retired after 34 years with Pratt and Whitney Company and enjoys sailing and M.I.T. Club activities from his new home in Falmouth. . . . **Sid Silber** and Jean write they continue to be busy in real estate development, in racing their Alberg 30 sailboat, and in trusteeship of a private secondary school. . . . **Sam Davis** is Mayor of Saint John, N.B., Canada, and **Jim Barton** is Mayor of Hunts Point, Bellevue, Wash.

Jim Barton and Mary reported the latitude and longitude of **John Alexander** and Nancy who continued their sailing adventure in the South Pacific. Last December 7 the Alexanders dropped anchor around Nukuhiva, Marquesas, in French Polynesia. Janie Alexander and Keith Barton started this voyage as crew, but this latest report does not detail whether these two young people have assumed total administration aboard, to release John and Nancy for other pressing activities related to complete retirement.

From all the foregoing we can see that interest in our 40th Reunion is high and increasing. So many classmates will be there that the others won't want to miss out on this once-in-a-lifetime opportunity to visit friends with whom we all started our careers, and who, ever since, have been accompanying peers. There is still time to be included if you call Seymour Sheinkopf at (617) 731-9163. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, Calif. 92037

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A special note from **Norm Klivans**: "Our class (always so innovative) will be trying a new event this fall. We are having a mid-Atlantic fall get-together at Hotel Hershey and Country Club on the weekend of October 12-14. Hersey, Penn., is beautifully situated in eastern Pennsylvania, yet within an easy drive of Pittsburgh, Washington, New York, and other major centers. There will be sports, sightseeing, a social program, a technical seminar if the weather turns to rain. Only 30 rooms have been reserved. Cost is about $50 per person, per night, in a full American plan with great meals. If interested (and we should be planning ahead), write to Norm Klivans at 14731 County Line Rd., Chagrin Falls, Ohio 44022."

The heat is on: **Robert W. McKinley** is working on a scheme for utilizing directly through windows the sun's heat and light. Sounds difficult without a lot of gadgetry, unless he means he is sitting in a window seat reading a good book.

Picking them up: **Alvin Guttag**, erstwhile class secretary, writes that he was first in the "over 60" group in last October's Dayton River Corridor "Half-marathon." He still tallies more than 40 miles on the run each week.

Second careers: **Richard T. Orth** retired from Varian Associates some years past, but he has been around the world with the International Executive Service Corps, twice to Taiwan and once to Lima, Peru. . . . **Ted J. Gundlach, Jr.**, down North Carlina way has also retired from the first career but keeps a hand in as a consultant.

Bay Area news: **Charles S. Godfrey** writes on his alumni fund envelope that he is into physics at Livermore Laboratory in Livermore, Calif.

Not so Gallup Poll: Recently we've sent a batch of ready-to-mail cards to class members, asking them to indicate their chances of attending the class reunion. A fairly decent random sampling of the entire class was used to select names. The returns are coming in, and it seems that about a third of the responses run to a "50/50" estimate of attending in June, 1980. No doubt there shall be changes of heart along the way. If you have received one of the cards, ship it back pronto, please. — **Frank A. Yett**, Secretary, 1405 Ptarmingan Dr., Walnut Creek, Calif. 94595

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Bob Edwards writes: "I am presently the program manager for a classified navy program at Sperry Reston Engineering Center in Reston, Va. I have been here five years after seven years at Singer Kearfott and 24 previous years on Long Island and in California for Sperry Gyroscope. Three children have graduated from B.Y.U, Ohio Wesleyan, and Cornell; a fourth is a junior in electrical engineering at R.P.I." . . . **Jim Thornton** retired from Egan Machinery Co. . . . **Clarence Stevens** has joined Freightliner Corp. as Quality Assurance Manager at the Eastern Parts Manufacturing Plant in Gastonia, N.C.

Sherman Betts informs us he is chairman of the Moore County, N.C., Chapter of the American Red Cross and president of the Moore County Historical Association. . . . **Thayer Rudd** had lunch at the Houston meeting of the Commercial Development Association with your secretary who is past president and director of the association. Also, **Frank Wyle** and I lunched in the Jonathan Club in L.A. His company continues to grow in sales and profitability. . . . I would like to locate our chemical engineering classmate from China, **Shen P. Hua**. His name is in the alumni directory but no address. Another chemical engineering classmate from the People's Republic of China is **Z. F. Li** who is in Peking. . . . Keep the news coming. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn.

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Bob Cunningham has been commuting to Spain and Switzerland while organizing and designing a seven-year weather modification experiment. The experiment itself is being run in Spain by an international group under the direction of the U.N.'s World Meteorological Organization. . . . **Chris Peek** reports that he is happy as a clam at G.T.E.'s Waltham laboratory with all the equipment and expertise necessary to develop all kinds of wonderful new products. . . . **Jim Fleischauer** has been promoted to manager of the Flex Film Products Group of A.M.P. Incorporated. It sounds like a nice job, but he doesn't give us much of a description!

Two retirements this month: **Elizabeth M. Kelly** has retired as Chairman of the Biology Department of West High School in Pawtucket, R.I.; **Lawrence Valade** is just telling us now about his 1975 retirement as Superintendent of Public Schools somewhere (unspecified) in Michigan. The interesting part is that he is presently Educational Consultant for the Michigan State Senate. I surely would like to hear from you about how you go about educating a whole Senate!

Kudos to **Frank McClintock** who received the Nadai Award of the American Society of Mechanical Engineers at its winter meeting. Frank's citation is as follows: ". . . for his milestone contributions to the understanding of the mechanics and mechanisms of the fatigue and ductile fracture of metals, and for his ceaseless efforts as an educator in the subject of mechanical behavior of engineering materials."

The planning meeting for our 40th anniversary class gift was held at the New York Alumni Center on January 31 — just a wee bit late to make this deadline. We will have all the news for all of you from **George Schwartz** in our next issue. — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

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If you are occasionally disappointed by an absence of notes, just remember what the condemned person said to the hangman, "No noose is good noose." **Hans Walz** sent in the 35th Reunion treasurer's report, which shows a net profit, before taxes, of $473 on sales of $10,278 (000 omitted) and a balance of $1,075 in our account. . . . **Bob Handler** is presently handling two major contracts for the R.C.A. Picture Tube Division in Lancaster, Penn. One contract is in Poland; the other in the U.S.S.R.

Leonard Croan writes that he is now working on manufacturing methods and technology at the U.S. Army Development and Readiness Command in Alexandria, Va. . . . **Angel A. (Tony) Del-Valle** writes that **Angel M. Gonzalez** was elected chairman of the board of Gonzalez Padin Co., Inc., the largest department store chain in Puerto Rico. **Gene Eisenberg** told me that he visited **Gonzalez** recently in San Juan, and that the main store plus about eight large branches keeps Angel quite busy.

William L. Sammons has been elected group vice president for the domestic air conditioning operations of Carrier Corp. Bill joined Carrier in 1945 as a field sales engineer, and became president of Carrier's Canadian subsidiary in 1967. More recently, he was president of the Carrier Consumer Products Division. . . . **Leo Feuer** was elected chairman of the board of the William Carter Co. in Needham Heights, Mass. He joined Carter in 1949 and has been president since 1970. Almost all of our children and grandchildren have been outfitted in Leo's haute couture. . . . **John Sewell** was elected a company vice president of Eastman Kodak and appointed general manager of the Kodak Apparatus Division. John joined Kodak in 1946 and has held various positions from design engineering through manufacturing management. Most recently he was assistant general manager of the apparatus division.

Herb Shivek, a member of the New England Sinai Hospital board of directors in Boston, has been appointed chairman of their building and maintenance committee. Active in the field of metal manufacturing, he is also a member of the Brookline, Mass., planning board. . . . **Walter G.**

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4. *Stephanie B.* Medical systems service engineering. Installation and test of new hospital radiographic and fluoroscopic x-ray system.
5. *Mel D.* Field engineering. Appraisal load testing of low and medium-voltage switchgear and power transformers for utility and industrial applications.

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Burning Coal in a Jet

By suppressing the formation of oxides of sulfur and nitrogen right at their source, a new technology for burning coal in a cushion of air and sand known as fluidized bed combustion may eliminate the need for scrubbing those gaseous pollutants from smoke stack emissions and help to open the way toward exploiting the United States' immense coal deposits. As much as one-third the cost of today's new coal-fired power plants is for expensive equipment to eliminate sulfur and nitrogen pollutants; the promise of fluidized bed combustion is cleaner emissions at lower cost.

Fluidized-bed combustors consist of a "bed" of limestone sand at the base of the combustion zone, held in agitated suspension by jets of air blowing into it from below. Crushed coal and limestone are injected at the bottom of the bed and are dispersed uniformly among the bed particles by the vigorous air flow. Most of the coal burns while within the bed; simultaneously the limestone — calcium carbonate — captures the sulfur contained in the coal by reacting with it to form particles of calcium sulfate. Coal ash and the calcium sulfate continuously overflow the bed into spillways from which they are collected for disposal.

In conventional coal combustors the coal is fed rapidly into one end of the combustion chamber where it mixes with air and is ignited by the high temperature in the chamber. The coal must burn completely before it is carried out the other end of the combustor by the air flow. Unfortunately, the combustion temperature must be maintained well above 1000° C. to prevent the flame from literally being blown out, and at those temperatures the nitrogen and oxygen in air combine into nitrogen oxides, pollutants that elude current pollution control devices. During the combustion process, sulfur within the coal reacts to form sulfur dioxide, the pollutant which must be "scrubbed" from the stack gas. And nitrogen in the coal combines with oxygen to add to the NO_x burden in the stack gas.

In fluidized bed combustors the processes are very different. The turbulent mixing of coal and hot sand particles maintains stable and uniform combustion at temperatures as low as 700 to 900° C., too low for production of nitrogen oxides from atmospheric nitrogen. The uniform low temperature also allows embedding steam tubes directly in the fluidized bed for highly efficient heat transfer.

A pilot-plant fluidized-bed combustor two feet square in cross-section has recently begun operation for the M.I.T. Energy Laboratory under the direction of Professor Janos M. Beér of the Chemical Engineering Department. Its purpose is a detailed investigation of fluidized-bed combustion processes; the goal, says Sarwan Sandhu, program manager, is a general mathematical model to predict emissions from and efficiency of fluidized-bed combustors. Such a model would aid in the design of full-scale power plants.

Professor Beér and Dr. Sandhu believe that the problem of nitrogen oxides produced from nitrogen in the coal can be solved with improved control of the bed processes. Recycling innovations which are in the pilot model seem to promise very low particulate emissions and near total fuel combustion. Cyclone separators are being tested to remove particles as small as one micron from the flue gases for reinjection into the bed.

Jim Nash-Webber, designer of the facility, says it will also be used to experiment with structural refinements of the combustor and particularly of the coal injection system to reduce the cost of future fluidized-bed furnaces.

Though fluidized-bed combustion has been under development since the early 1960s, the extra cost of these complex combustors made them uncompetitive until the Clean Air Act required installation of pollution-abatement equipment on conventional combustors. Now, however, the economics appear to be quite favorable. The fact that fluidized-bed combustors are tolerant of wide variations in coal quality, their compact design due to high heat transfer rates, and their low pollution promise significant system savings, according to the M.I.T. Group. — *Jere S. Meserole, Jr.* □

Taking the Pain Out of Writing — at a Console

It's late, and George has to finish his term paper by tomorrow "or else," his professor told him. At 2:10 a.m. the final page of the first draft comes out of George's typewriter and he gives up. He knows it isn't the best paper, but he simply doesn't have time to rewrite it.

Could a computer-based "text editor" help George, and perhaps change the way in which he and other students write and think about their writing?

A student using such a text editor types his material on a keyboard similar to a typewriter, and it appears on a television screen. He can then make changes — insertions, deletions, and corrections — without ever having to pick up an eraser. The machine stores his text, and when George has finished revising, a high-speed printer produces an error-free copy of his paper.

Text editing is not new but has only recently been adapted to classroom use. As a consultant to E.C.D., a Cambridge microcomputer firm, Kenneth Skier, '74, lecturer in the M.I.T. Writing Program, has developed a text-editing system which can be quickly and easily mastered by people who have had no previous computer experience. The commands for "insert," "delete," and other similar revisions are printed on the keys, and each key does exactly what it says; students can make revisions after five minutes of instruction.

Over 100 students, most with no previous computer experience, used such text-editor systems over the summer at Cornell, where Mr. Skier was then teaching; three systems ran an average of 15 hours a day, six days a week. There were few difficulties, and most students liked it. Cornell has now incorporated the text-editing systems into its permanent writing program.

This fall, Mr. Skier is introducing the use of text editors in the writing process at M.I.T. with help from students working under the Undergraduate Research Opportunities Program. These students will teach others to use the editors, and they will collect data on how the editors affect students' attitudes toward writing and revision.

What effect will this new technology have? It is too early to tell. The text editor makes revision easier, but will students revise more? And if they do, will they necessarily produce better writing? And will students who are impatient with writing find this new tool so helpful that the whole process becomes easier and even enjoyable? — *Randy R. Ross, '80* □

An Arm for Outer Space

What's over fifty feet long, has a shoulder, elbow, wrist, and hand, and can handle 65,000-pound objects? It's not a cloning experiment gone haywire; it's the Shuttle Remote Manipulator System (S.R.M.S), the arm on the space shuttle.

The shuttle, the first reusable spacecraft, will operate a space-age delivery service. The bulk of its fuselage (about the size of a DC–9 jetliner) will be a 65-foot-long cargo hold, the payload bay. Before launch the bay will be filled with up to 32 tons of cargo — satellites, laboratories,

and experiments. Once in space, it will be up to astronauts using S.R.M.S. to deploy the cargo. If necessary, the same arm will be capable of retrieving objects which are already in space. This ability to deploy and retrieve objects in space makes the shuttle an especially valuable tool in the U.S. space program.

S.R.M.S. is made up of lower and upper arm booms — with an "elbow" joint in between and "shoulder" and "wrist" joints at the ends. The shoulder joint, attached to the fore end of the payload bay just behind the cabin, can pivot up and down and right to left; the elbow moves up and down; and the wrist has three directions of motion: up and down, right and left, and roll. Each joint has electric motors for power.

Attached to the wrist is a snaring device — called an end-effector — which looks like a large tin can closed at the end attached to the wrist and open at the other. Three snaring cables at the open end operate much like the iris of a camera to open and close on targets which are fitted with a grapple fixture — a metal rod with a knob at the end. When the end-effector is properly positioned, the cables tighten around the rod and pull back against the knob, so the payload is rigidly attached to the arm.

The shuttle pilot manipulates the arm with two hand controllers, one of which can change the location of the end effector in space and the other its orientation. One of the shuttle's onboard computers translates commands from the hand controllers into appropriate signals for the motors. The calculation involves a transformation from "task space" — the coordinate system defined by the position of the end effector — to "configuration space" — the coordinate system defined by the actual geometry of the arm. With the computer doing these calculations, operating the arm with the hand controllers is much like flying a spacecraft — something very familiar to the pilot. (Should this system fail, there is a backup system consisting of individual, rate-controlling switches for each of the arm's motions.)

The pilot "flying" the arm may be able to see it through one or both of two windows in the cabin: one looking aft into the payload bay and one looking overhead. Closed-circuit television viewing is also available. Cameras are located on the fore and aft bulkheads of the payload bay and on the "wrist" of the S.R.M.S. The wrist camera gives the pilot the sense of immediacy needed when flying the arm.

Research and development for the S.R.M.S. was funded by the National Research Council of Canada, providing a boost for the Canadian aerospace industry. — *Mitchell Weiss, '79* □

The Wrong Way to Clean Water

At least $300 million has been spent by planning agencies to study means and write plans for cleaning up rivers and harbors. But most of this money, made available under grants from the Environmental Protection Agency, has been wasted, says Thomas D. Lustig, who completed his Ph.D. thesis on the subject last June.

The problem was mostly bureaucratic mismanagement, says Dr. Lustig. No one really asked the right questions: Would the plans work and could they be funded? So the planning became a theoretical exercise in setting goals and meeting them. "The principal faults," he writes, "had little to do with the technology of cleaning water and much to do with the political, financial, and administrative impediments inherent in environmental planning." □

Getting the Message Into Scientific Communication

If scientists swapped ideas more often, innovative research — and its payoffs — could be greatly stimulated. But the fact is that scientists don't talk with enough of their immediate colleagues, let alone more remote researchers: there's not enough time. Research reports have problems, too. They are slow to see print; most don't immediately communicate the main point; and they generally omit several kinds of useful information.

Theodore Melnechuk, a communications scientist at the Western Behavioral Sciences Institute, suggested ways of solving these communications problems at the recent meeting of the Society for Neuroscience in St. Louis. As founding editor of the M.I.T. *Neurosciences Research Program Bulletin* he grappled with the challenges of summarizing fast-breaking, complex scientific advances, and he has some suggestions to reduce unnecessary barriers to scientific communication:

□ Annotate entries in professional directories with a brief description of each member's area of expertise and current interests, so that strangers working on similar problems can more readily find potential collaborators.

□ Use complete statements for journal article titles, and not just phrases that label the subject, for easier identification.

□ Publish "state-of-the-field" bulletins containing summaries of current research and well-informed views of research trends.

□ Establish computer networking communications links among laboratories across the country — a sort of scientific CB.

Most scientists are willing to talk about much of their work, especially if allowed to correct what is attributed to them in the media. If Mr. Melnechuk's ideas win acceptance among research scientists and administrators, only benefits to the pace and quality of research are likely to accrue. — *Christopher F. Dippel, '75* □

The Government's Roles as Granter and Intervener

"Unusual and important uncertainties" as well as "significant accomplishments" characterized 1977-78 at M.I.T., say President Jerome B. Wiesner and Chancellor Paul E. Gray in their annual report as the Institute's principal officers.

The uncertainties:

□ The impact of inflation, which is especially "corrosive" on institutions which depend on endowments and gifts.

□ The effect of rising costs on the quality and mix of students attending the Institute.

□ The cost and other consequences — often "incompletely considered" — of government interventions.

The year's accomplishments included organization of the Whitaker College of Health Sciences, Technology, and Management and of a similar entity in science, technology, and society; curriculum developments in architecture and engineering; new research strength in combustion, energy policy, and energy technology; and the ever-closer involvement of students, both graduate and undergraduate, in M.I.T.'s growing research programs.

Among the most difficult of the government's interventions in 1977-78 were these, said Drs. Wiesner and Gray: increasing contributions to Social Security, difficulties for foreign scientists and engineers who want to work at M.I.T. as permanent residents of the U.S., possible changes in government reimbursement for research, and changing interpretations of minority admissions policies.

With respect to the latter, M.I.T. believes its practices are consistent with

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those approved by the Supreme Court in the "Bakke case"; but the issue of research reimbursement continues to be a cause for concern. Draft regulations published a year ago by the Office of Management and Budget "would cause arbitrary reductions totaling about $2 million per year in our reimbursement for necessary and proper indirect costs," write Drs. Wiesner and Gray. At the same time, the regulations would "greatly reduce ... flexibility" and — despite the traditional involvement of graduate students and the growing participation of undergraduates in research — would discriminate against students working in research. □

Shooting Down Housing While Firing at Inflation

When the Federal Reserve Board restricts the money supply to curb inflation, it triggers a depression in the housing industry born of high interest rates and scarce mortgage money. That's now happening for the eighth time since World War II; the result is that residential construction, the "handmaiden of monetary policy," is one of the most volatile sectors of the economy.

It shouldn't be so, say Carol Coorado and Thomas Cooley, research associates at the Joint Center for Urban Studies of Harvard and M.I.T. Using a large-scale econometric model, they conclude that less restrictive monetary policies in times of inflation would have stimulated the economy, especially the housing sector. Monetary stringency, they say, cost dearly in terms of economic growth and employment, precisely the opposite of the intended effects. □

Fast Access to Regional Data

Tabulations from large data files on regional economics and development are now available at high speed and low cost from a new service called Access developed by a Program on Neighborhood and Regional Change in the M.I.T. Laboratory of Architecture and Planning.

Access is available to users throughout the U.S. through telephone interconnections. It is now tied into files of individual and business data from such sources as Dun and Bradstreet, the U.S. Census, and the Social Security Administration; and to geographical data yielding information on population, employment, climate, housing resources, etc.

The Access package involves only English-language computer programs, is self-instructing, and can be used in connection with any large data bank, according to David L. Birch, Director of the Program on Neighborhood and Regional Change. Its development was funded by the Department of Housing and Urban Development, the Department of Transportation, and the Economic Development Administration. □

Deflating Urban Optimism

When a suburban family tires of country living and returns to the excitement of rebuilding a central-city house, wishful thinkers and journalists call it a sign of urban revitalization — a back-to-the-city movement that is becoming a major force in arresting central-city decline.

Not so, says Philip L. Clay, assistant professor of urban studies and planning.

After studying 105 neighborhoods in 30 cities, Professor Clay says cities are still losing ground. For every neighborhood that is improved by new owners and new capital, several have declined. He estimates that revitalization has affected "less than 5 per cent — and in most cases less than 2 per cent — of central city housing units and it is relatively small areas within larger districts which are revitalized."

Yet never underestimate the power of an idea, he says. Successful examples of revitalization have "precipitated an important spiritual and psychological" lift, and "for many a big city mayor and central city people a glimmering hope is sustained that cooperation, diligence, commitment, private resources, individual initiative, and government aid can combine to offer substantial improvements for urban life." □

High Rating in Business

M.I.T.'s Sloan School of Management ranks third among the nation's business schools in a study commissioned by the University of California Regents; Stanford is first and Harvard second. Members of the Laboratory for Research on Higher Education at the University of California (Los Angeles) queried more than 1,600 faculty members and deans throughout the nation who rated business, law, and education schools on the "quality" of various aspects of their programs.

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Don Hartman found a "model" way to troubleshoot the network.

The nationwide telecommunications network carries over 515 million phone calls on an average business day. Only a small number of them run into trouble, such as failing to go through the network, getting noise on the line, or being disconnected prematurely. Craftspeople in Bell telephone companies fix most of these problems quickly. But the causes of some can be difficult to find among one-billion-plus miles of circuits and thousands of switching offices.

For several years the Bell System used its computerized Network Operations Trouble Information System (NOTIS) to try to pinpoint those causes by analyzing trouble reports from all over the country. NOTIS was good. But Bell System managers wanted it to be better, more precise in identifying possible trouble spots. And they wanted the data in compact, easy-to-use form.

We assigned a new employee, Don Hartman, to improve NOTIS. Don came to us with a B.S. from the University of Texas and an M.S. and Ph.D. from Massachusetts Institute of Technology. He and his associates developed a second-generation system (NOTIS II) that does the job superbly.

For the new system, Don developed a mathematical model of the telecommunications network, including 28,000 local and long-distance switching offices and nearly a half-million circuit groups. Don also designed the system software and served as a consultant to the team of Bell System programmers assigned to the project.

Each day trouble reports from the entire country are sent to the NOTIS II center in Atlanta. Overnight, the system analyzes the reports, processes them through the network model, and discerns trouble "patterns" which help identify potentially faulty equipment. By 8 a.m. the next day, via data links, analysts at phone company service centers receive information on troubles traceable to circuits or switching equipment in their territories. Result: Better equipment maintenance. And better service.

With NOTIS II up and running, Don has moved on to other projects. Today he's a supervisor with broad responsibilities for planning the telecommunications network of the future.

If you are interested in exploring equally challenging employment opportunities at Bell Labs, write to:

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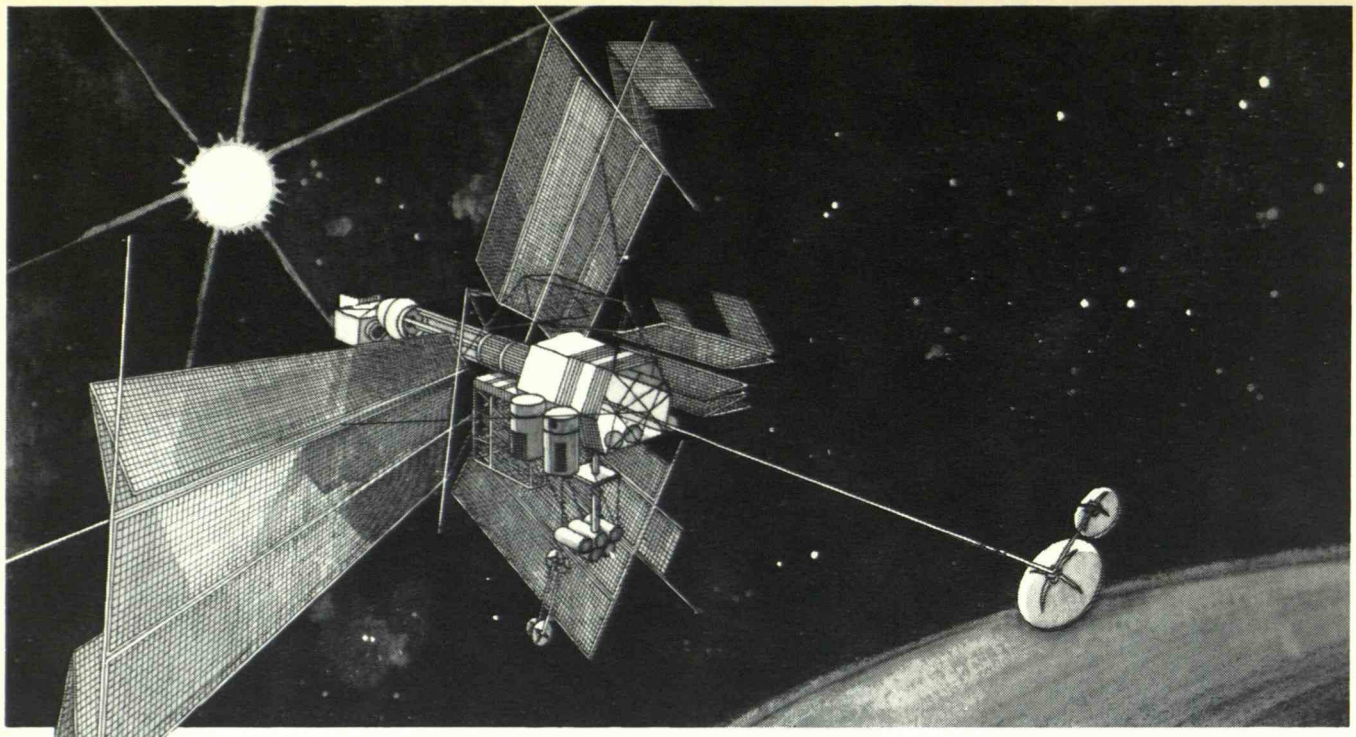

We need people to meet the challenges of the future.

And some that we already have. In short, we need fine 21st-century minds. Now.

Should immense solar power stations be placed into stationary orbit around our planet, as drawn above? How will we extract oil from shale, yet preserve the environment? How will we transform the heat of the earth into useful energy?

We need people from scores of skills and disciplines. People who are seeking careers in chemical engineering. Computer science. Electrical engineering. Geology. Geophysics, mechanical engineering, mining engineering, petroleum engineering, petroleum land management. And accounting and business administration.

Because America's economy depends on finding new reserves of energy, new sources of energy, new forms of energy.

To perform these challenging tasks, Gulf needs good people.

If you would like to play a part in the solutions, please make an appointment to see one of the Gulf Human Resources representatives who will visit your campus. Or, if you prefer, write Mr. J. V. Crawford, Human Resources Department, P.O. Box 1166, Pittsburgh, Pa. 15230.

It could be very rewarding to join the Gulf people who are meeting the challenge.

Gulf

Gulf people: meeting the challenge.

Gulf Oil Corporation *An Equal Opportunity Employer*

Sutton, Jr., manager of the construction department for hydro and community facilities for Bechtel, died last June in a small plane crash in British Columbia. He was responsible for many projects in the Middle East, as well as in this country, and in South America. . . . **Dr. Neil Campbell**, of Spokane, Wash., also passed away last summer.

Margot and I attended the Hartford area road show of the M.I.T. Shakespeare Ensemble, and were highly impressed with the professionalism of these undergraduates. At a reception following, I told some of them that in my day our exposure to theater was limited to the Old Howard, The Globe, and sometimes the Crawford House, which produced a different kind of Lear than the one this group will put on this spring. — **Richard M. Feingold**, Secretary, 799 Prospect Ave., West Hartford, Conn. 06105

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We have much news to report this month. The Alumni office sent us a delightful note from Larrie Reed, wife of **Robert R. Reed**. She writes of the mountains and scenery in Littleton, Colo., where they are now living after many years in Wellesley, Mass. Bob, who is with Martin-Marietta, is originally from Newton while Larrie hails from Connecticut. . . . From **Andy Corry** we heard the very first news about the election of **Henry C. Bourne, Jr.** to Fellow of the I.E.E.E. Congratulations, Henry. . . . **Roger M. Freeman, Jr.**, president of Allendale Mutual Insurance Company, has been appointed a trustee of Bryant College in Rhode Island. . . . In mid-January, Newton was just getting settled in an airplane seat for a cross country flight when he recognized **Alexander Kusko** getting into the seat ahead. Quite a surprise to Alex — he didn't know he was a famous member of the class of '44. Alex has had his business card as an ad in the *Technology Review* long enough to be well known among his fellow alumni.

Special congratulations go to **Bob Meier** — more properly the Reverend Robert L. Meier, whose 25th anniversary of ordination was celebrated by the congregation of the Maple Street Congregational Church in Danvers, Mass., where Bob has served as senior minister since 1964. Through the radio ministry of Maple Street Church, Bob's voice and messages are well known in the area.

Don't ever doubt the power of a flap on an Alumni Fund envelope! **Robert Burdick** wrote in, worried that he was not affiliated with any class. Well, he is hereby welcomed into the class of '44. If he will appear at the festivities in Cambridge and/or Bermuda, we'll welcome him with proper ceremony.

M.I.T. in the next generation: **Arthur F. Dershowitz** writes of two sons and a new daughter-in-law — all M.I.T. Bill works in Geotechnical Engineering; Daniel, '76, is working toward his doctorate and, by the time this note is published, has married an M.I.T. woman. Arthur has completed 30 years with G.E. and is working in the Corporate Strategy Staff.

Ed Ahlberg, who has been a regular at committee meetings, reminds all to attend the Bermuda reunion in June. . . . **Bill Rodemann** writes that he's planning to join our 35th Reunion in Bermuda. Bill's note brings us news of **Bob Fisher** (in Atlanta, Ga.) and **Holton Harris** (Harrel, Inc. in Conn.). Bill is currently vice president at Control Data Corp. in Minneapolis. . . . From deep in the mid-January ice pack around Chicago came a letter from Barbara and **Scott Carpenter**. They are planning to join us in Bermuda in June. Quite a switch for the Carpenters; they're usually in the center of reunion committee activities. . . . Dr. **Andrew M. Margileth** is professor of Child Health and Development at George Washington University Medical School and also Director Outpatient Department, Children's Hospital, National Medical Center in Washington, D.C. Andrew went to medical school directly from graduation at M.I.T. in 1944 and rose to rank of Captain, U.S. Navy. We hope he joins us in Bermuda. We may not need pediatrics but I suspect we'll need medical attention. . . . **William C. Sadler**, Ocean Engineering, writes that he'd like to see a 35th Yearbook similar to the one for the 25th. So would we. But it is a tough, grinding job. The **Stan Warshaws** and the **Lou Demarkles** can tell you how tough it was. Perhaps we can get the right combination of volunteers at our 35th to put one together for our 40th.

Priscilla and **Bob Breck**, **Andy Corry**, **Bob Horn**, Nancy and **Norm Beecher**, Marguerite and **Ed Ahlberg**, **Stan Warshaw**, and Ruth and **Norm Sebell** enjoyed the warmth of the hospitality of Anita and **Les Brindis** at their home on a snowy evening in January. At that time too few responses to Norm's reunion letter had been received to make the final reunion plans. However, just two weeks later the response had been most gratifying. By the end of January, Norm had received over 40 positive responses and the committee had been stimulated to expand the Cambridge activities. Norm would like to have you add your ideas and desires to your reunion card — what you want and when you want it. **Norm Sebell** would like *you* to keep those cards and letters coming. — **Melissa** and **Newton Teixeira**, Co-Secretaries, 92 Webster Park, West Newton, Mass. 02165

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Thank you for the many notes on the flaps of the Alumni Fund envelopes. One individual even contributed twice, money and news. Double thanks! . . . **Carl Eyman** is looking toward our 35th Reunion: "Hope it is off campus; I'd like to attend if it is." One way to influence things, Carl, is to volunteer to serve on the reunion committee. You'll be hearing from someone, no doubt.

A note from **Ed Friedman** (now Class of '50, but he began with the Class of '47) sends his new address for anyone who would like to get back in touch with him: 115 Kensington Ave., Apt. 3, Meriden, Conn. 06450. He is at the University of Hartford. . . . Season's greetings from **William M. Heyser**. (There's a bit of a lag, Bill, between Alumni Fund receipt of your note, my getting it, and publication. . . so how about HAPPY EASTER for the season?) Bill is a member of the American Chemical Society and the Oklahoma Zoological Society. (He is the son of Lt. Col. M. C. Heyser, Grosse Pointe, Mich.) . . . **Ruth W. Mileson** writes: "I'm just ending my fifth year in Kansas City working for the Genetics Counseling Service at Children's Mercy Hospital in a clinical and research laboratory. My older daughter Susan was married in Seattle in October, and younger daughter Beth is in northern Virginia." Ruth's address is 5907 Rockhill Rd., Kansas City, Mo. 64110.

From **Walt Kern**: "I'm still at Teradyne doing system packaging and test fixturing for semiconductor and card testing." His daughter Jill graduated in material science from M.I.T. last year, married Jeff Grossman (computer science), and is quality assurance engineer at Babcock and Wilcox in Augusta, Ga. Walt says all is well and is playing a lot of tennis. . . . **John Karmazin** writes that Karmazin Products Corp. has broken ground for the new research and development facility scheduled for completion in June. John says, "With the implementation of this expansion we anticipate that we will be utilizing our membership in the Associates Program even more." In *Karmazin News and Views*, the M.I.T. Beaver, complete with musket and coonskin cap, is shown saluting a new 50-inch copper brazing furnace. John comments on the beaver's alert look, . . . if he was 'for real' he would lead us to a good restaurant with no delays."

Bob Creek has been elected to his ninth term as local school board president. He also serves on the National School Board's Federal Network. Other activities include working for Phil Crane for president and cheering his 15-year-old daughter on to victory in the West Coast A.A.U. Diving Championship in August.

You probably noticed that **Jordan Baruch**, Assistant Secretary of Commerce for Science and Technology, is booked for Technology Day, June 8,

A Report on the Law in Maine

Everything is on the rise for the legal profession in Maine — except its numbers.

Items from a status report by Vincent L. McKusick, '47, Chief Justice of the Maine Supreme Judicial Court, to the annual Business Breakfast of Husson College, Bangor, late last year:

— Maine's Law Court is receiving new cases and handing down decisions on older ones at the rate of one a day — just over 360 a year. As recently as two years ago the number was less than 275, and in 1966 only 78 cases were filed.

— The case load of District Courts in Maine is also up sharply — over 15 per cent in 1977-78 over the previous year. That represents 187,000 cases — a "staggering" number — in 33 different jurisdictions.

— The number of people passing the examination and admitted to the bar in Maine peaked at just over 200 in 1977; admissions are now on the down-turn, thinks Justice McKusick — 155 in 1978, he reported.

— Expenses to provide representation for indigent criminal defendants in Maine were $784,000 in 1977-78, up 47 per cent over the previous year. It's a constitutional obligation to provide this aid, said Justice McKusick, "but we must be sure that every dollar is well spent."

1979, to discuss expanding the scope of industrial innovation in the United States. He continues to bring his concerns into suitable forums. In November he was the keynote speaker at the combined meeting of the Licensing Executives Society International and the Licensing Executives Society (U.S.A.), speaking on "Inter-industry Technology Transfer — A Missing Link in Industrial Development." He feels that what has been learned about transferring technology to less developed countries could be used in fostering technology transfer to less-developed industries, and that the professional licensing executive has a critical role to play.

Horace Robson, '47

Horace Robson has been named Manager of Air and Water Resources at Union Camp Corp. Horace joined Union Camp as a chemical engineer in 1950, after taking a master's in chemical engineering at Cornell. He has been technical director for the company's Montgomery, Ala., mill and assistant technical director for its unbleached division. He is also a past chairman of the Southeast Section of the Technical Association of the Pulp and Paper Industry.

Next month a recap on Who Is Sitting with Whom in the Chairs of THE SEVENTH ROW in 10-250. There's still room for more and the fare has not gone up. Love, Ginny. — Virginia Grammer, 62 Sullivan St., Charlestown, Mass. 02129

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Frank Jamerson is still running the physics department at General Motors Research labs. Frank's sons, Bruce and John, both graduated from the Sloan School with M.B.A.'s after attending the University of Michigan. Bruce is with Citicorp and John is with Dean Witter Reynolds. . . . **John Kail Crane** continues as Chief Engineer of Technical Services and Public Affairs with the Cook County Highway Department in Illinois.

Ed Kratovil writes to say he is hoping to attend our 35th Reunion. . . . **Bruce Morrell** is a partner in a consulting engineering firm doing mostly energy studies. Bruce has been in Colorado Springs since 1974 when he retired from the Air Force.

Morton Levin is Manager of the Product Safety and Performance Assurance Department for the Waltham, Mass., facility of the Medical Products Group of Hewlitt-Packard. When Morton joined the group in the 60s it was the Sanborn Co. In those days Morton designed DC amplifiers for recording systems and data acquisition applications. In 1968 he had progressed to manager of the research and development lab. In the 1971-72 academic year Morton was a fellow of the Advanced Engineering Program of the Center for Advanced Study at M.I.T.

Morton spoke to a joint meeting of the Engineering Management and Engineering in Medicine and Biology Chapters about the Impact of Medical Device Legislation on the health industry. Regulations based on 1976 amendments to the Food, Drug and Cosmetics Act are being implemented. The regulations place controls on the clinical evaluation of new medical devices prior to introduction, during their introduction, and during their manufacture. Devices have been defined to include any instrument, apparatus, or contrivance intended for use in the diagnosis of disease or other condition in man or other animnals. Morton tions that are likely to have the most impact on the discussed the provisions of the federal regula- health care industry. He suggested some actions that the industry needs to take.

Joseph C. Nowell, III died in November 1978 in San Rafael, Calif., where he had been living for the past four years. Joe was a vice president at Flow Resources Corp. He was a vice president of General Reserach in Santa Barbara prior to moving to San Rafael. Joe had worked at M.I.T. and at Raytheon in Massachusetts before moving to California. On behalf of our class I extend our sympathy to his wife Stephanie and their children. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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Looking out at snow streaming off the roof-edge in near-zero wind, I find myself eagerly anticipating our 30th Reunion, June 7-13. As you read these notes, the moment of decision for *guaranteed* rooms in Bermuda is past. However, if you decide that you would like to join us in Bermuda, call or write me today and we might still be able to make the necessary arrangements. Final confirmation and cash deposits for the on-campus portion of the reunion are due shortly. Get yours in soon to assure yourself seats for the Pops.

News from classmates from Alumni Fund notes: **Thomas J. Lamphier** was elected to the Board of Directors of Amtrak last September. . . . **Terrell Marshall, Jr.** is now chairman of the Department of Electronics, Computer and Energy Studies at Spring Garden College in Philadelphia. . . . **Herb Spivack** writes he is "the president of, and a major stockholder in, several companies serving the epoxy resin field: Metachem Resins Corporation, Mereco Products and Arandee Associates. I have been elected vice-chairman of the Epoxy Resin Formulators Division of the Society of the Plastics Industry and am responsible for public relations. The E.R.F. Division is the umbrella trade association for leading companies in the field; it formulates guidelines and advises its membership on product standard test methods and interface policies with regulatory agencies — E.P.A., O.S.H.A., D.O.T., T.O.S.C.A., etc. — as they affect the member companies in our industry."

I'll see many of your at our reunion. Best wishes to all — **Frank T. Hulswit**, Secretary and Reunion Chairman, 77 Temple Road, Concord, Mass. 01742

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Stephen H. Senzer owns and operates S. H. Senzer and Associates, a market consulting and research firm, specializing in service to the plastic and packaging industries. They are located in Cornwall, Conn. . . . As of August 1, 1978, **Roy W. Roth** joined the Pall Corp. located in Glen Cove, N.Y., as a special projects leader. . . . We were deeply saddened to hear of the deaths of two of our classmates. **Thomas Cerwonka** passed away on November 28, and **William F. Arnold** died on August 26.

Joseph B. Oppenheim plans to take a course in science fiction writing at the Florida Institute of Technology. . . . **Fred Werner** wants to let us know the further benefits of being an American Field Service host family. He, his wife, and one daughter visited their "daughter" in Arequipa, Peru, last fall. It was a wonderful family visit in a perfect climate — dry, warm, and sunny. Fred tells us that the Peruvians are warm and big-hearted people. He also recommends staying overnight in Mocchu Picchu, watching the sunrise, then climbing Huenyn Picchu (the peak behind Macchu Piccu in all the pictures); it is sheer magic. All this came from being involved in A.F.S.; Fred recommends it to everyone. — **John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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Springtime greetings from the east — where longer and warmer days beckon golfers from their hibernation. We have several news items about the winter activities of '51ers.

Donald Lee Brown, an architect at Reynolds Metals Co., was remarried in 1978 and is now raising three teenagers in Richmond, Va. He has been designing aluminum houses for shipment to Iran, Saudi Arabia, and Venezuela. . . . **David Caplan** has returned to Raytheon as vice-president and general manager of the Intelligent Terminal Systems Division, after two years as vice-president of engineering at Inforex. It was a big Caplan milestone when David's son, James, graduated from M.I.T. in 1978.

John Conley is now director of marketing and sales at Neway Division of Lear Siegler. John, his wife Skip, and his three sons live in Muskegon, Mich. . . . In 1978, **Garth Coombs** was elected a Fellow of the American Institute of Chemical Engineers in recognition of his outstanding contributions to the field of industrial mineral product development, for his interest in helping and training new engineers, and his long service to members of the chemical engineering profession. Garth was former chairman, and is now a regular member of the Rocky Mountain Section of A.I.Ch.E. He is research manager of Johns-Manville Sales Corp. in Denver, and lives in Evergreen, Colo.

Marvin Grossman has been awarded a 1978 Bronze Beaver! Marv has been generous with his time, creative in his approach, sensitive in his leadership, thoughtful in his opinions — and an invaluable resource to alumni, faculty and staff of M.I.T. and the Alumni Association. Marv's son, Dan, is a sophomore in physics at the Institute. . . . **Ken Kruger** advises us that both the Cambridge, Mass., and Newark, N.J., offices of his firm — Kruger, Kruger, Albenberg — are involved in evaluation of building, including technical investigations, legal testimony, managing repairs, capital improvements, and energy conservation. Last fall, the *Boston Herald American* photographed Ken lying down on the job, inspecting a dirty chimney and fireplace. Pretty soft, the life of an architect and engineer.

Anthony Kurtz received the Si Fluor Technology Award during the International Instrumentation-Automation Conference and Exhibit of the Instrument Society of America in Philadelphia. Anthony was cited for distinguished achievements in the development of silicon strain element technology and minature silicon pressure transducers. Anthony has been President of Kulite Semiconductor Products since 1960, and serves also as Chief Executive and Principal Scientist. . . . During the past three years, **John Lowry** has solved the technical problems of startup in the new technology of portable visual communications, in his capacity as vice-president of Izon Corp.

In New York City, **Anthony Mirti** has joined Otis Elevator Co., subsidiary of United Technologies Corp., as vice-president for technology, responsible for coordination of worldwide technical activities. Previously, Anthony was vice-president for operations and production of the Sikorsky Aircraft Division of United Technologies. . . . **Orlo Powell** has been appointed assistant dean and associate professor of mechanical engineering at Western New England College in Springfield, Mass.

Two former M.I.T. hockey players were in the '51 news recently. **Fred St. Laurent** was appointed vice-president of Bellofram Corp. in Burlington, Mass. Fred, his wife, and his daughter live in Marblehead. . . . **Hank Spaulding**, chairman of Spaulding and Slye, continues to develop, build, and manage real estate ventures. Hank has moved the Spaulding and Slye headquarters to Burlington, Mass. Did anyone see Fred and Hank at the Alumni hockey game?

Ed Stringham merged his firm into Carborundum in 1976, and retired in 1978 to do a lot of traveling, reading and developing other interests. . . . **Daniel Sullivan** has been designing passive solar houses in the northeast. On sunny days,

Dan heats his Cape Cod office with an attached passive solar greenhouse and enjoys the fruits and flowers he grows there; in the winter, Dan commutes to his office in St. John, Virgin Islands.

We extend our sincerest sympathies to the families of **William C. Reisener, Jr.**, of Exton, Penn., and **Robert R. Stephenson**, of Oakmont, Penn., who died last year. — **Sam Rubinovitz** Secretary, 3 Bowser Road, Lexington, Mass. 02173; **Paul Grady**, Assistant Secretary, 16 Brook Lane, Greens Farms, Conn. 06882

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Arnie Kramer, who is among other things our unofficial third secretary and news gatherer, has provided some grist for our class letter. First he notes that '52 has some super athletes, among whom are **Stan Sullivan**, who needs only two or three more conquests to climb the 100 highest peaks in New England; and **Gil Steinberg**, who recently ran in the New York Marathon and *finished*. . . . From Australia comes a short note from **Brenton R. Groves**: he has quit the academic world, where he was Dean of Engineering and Applied Science at the Gippsland Institute of Advanced Education, to go into business for himself advising first-time computer users. The first few months were slow, Dr. Groves writes, and he lived on his wife Lois's teaching salary; but at the present time he is completely booked up through March — which is good because Australia usually closes for December and January. For the last four years jobs for engineers in Australia have been close to nonexistent, but now things seem to be picking up. "For anyone interested in coming here *The Australian* is the paper to read."

Edward A. Ryan, Jr. writes that in June, 1978, he was promoted to Vice President of Star-Kist Foods, Inc., where he is responsible for research and development and government-industry relations. He also serves as assistant to the president. . . . In Miami, **Theodore M. Parsons** is an account executive with Merrill Lynch. . . . Anyone interested in computer process control systems for the manufacture of large-scale integrated circuits should write **John W. Gaylord**, who is working in that area at RCA. John is interested in comparing notes.

Art Freeman has just returned from a leave of absence in Munich where he was a Humboldt Senior Fellow. Art has returned to Northwestern University where he is a professor of physics active in solid-state-theory research. . . . **Dick Wingerson** writes that he is enjoying retirement and involvement in community affairs as chairman of the local zoning board, member of the county planning commission, and co-founder of a citizens' group for responsible development. Dick is a resident of Crested Butte, Colo. . . . The Director of the Office of Systems and Advanced Technology, National Oceanic and Atmospheric Administration, is **Dan Lufkin**, a new job which Dan says promises relief from the "retarded technology" he's been associated with in the past. Dan is still teaching astronomy at Hood College part-time this semester. The course is Cosmology for Pedestrians. He is also consulting in solar energy and doing free-lance translation.

Edwin H. Porter, Jr. is Special Assistant and Vice President at the Charles Stark Draper Laboratory. Edwin is still recovering from coronary bypass surgery performed this summer at Massachusetts General Hospital. . . . "Chemistry and the Oil Industry on the Coast of Maine" was the subject of a lecture delivered at Bowdoin College on October 25 by **Dana W. Mayo**, Charles Weston Pickard Professor of Chemistry at Bowdoin. In recent years Dana has been turning his attention to marine oil pollution, and he has lectured and written on the effect of oil spills on the marine environment.

The General Tire and Rubber Co. in Akron, Ohio, has announced that **Eugene D. Scalera** has joined the Chemical/Plastics Division of General Tire as Vice President. Eugene was formerly Vice President of Operations at the Joseph Schlitz Brewing Co. and President of the Singer Co.'s Climate Control Division. He and his wife, Mary, are the parents of a daughter and two sons. . . . **Nick Haritatos** writes that he has been working on a fertilizer project and on lubrication oil additive facilities for the Chevron Chemical Co. this past year. Also Nick teaches the ninth-grade Sunday school at the local Greek Orthodox Church in Richmond, Calif. After three years, Nick finally graduated from Cub Scouts, but his son is still undecided whether to join the Boy Scouts. His wife, Nancy, has her hands full as P.T.A. president this year. . . . The new chairman of the Department of Continuing Education in Business Management at the University of California Extension, Berkeley, is **John F. Maxwell**. Most recently,

That plaque in the hands of Breene M. Kerr, '51, now identifies a healthy sapling in the garden outside the M.I.T. Alumni Center — an "Oklahoma redbud" tree given by Mr. Kerr "to honor students from Oklahoma and the southeast who have attended the Institute over the years." The picture was made during a presentation before the M.I.T. Club of Oklahoma in November; with Mr. and Mrs. Kerr are Mr. and Mrs. Joe F. Moore (Mr. Moore, left, was acting as president of the Alumni Association in the ceremony).

Proposition 13 and California Business: The Jury Is Still Out

What's happening to California business as investors and would-be investors grow used to the idea of Proposition 13?

Nothing — yet, says Paul P. Shepherd, '53, who's a consultant in industrial development and real estate in Daly City, Calif.

"The business attitude toward increased investment in California is still 'wait-and-see'," he says. "Up to now, Proposition 13 has had virtually no discernible effect upon industrial and commercial development in the state."

That judgment may surprise a lot of Proposition 13 supporters, Mr. Shepherd admits; they had promised a "large, speedy increase in investment" when the tax ceilings were imposed. But their fire was misaimed, thinks Mr. Shepherd: the reluctance of would-be investors in California had nothing to do with local property taxes; it was the result of "proliferating" regulation at the state level and the resultant increases in paperwork and delays in decision making.

The unanswered question, says Mr. Shepherd, is whether Californians will accept the reduction in public services implied by Proposition 13. If they don't, then unregulated sources of tax money will have to substitute for the income denied government from local property taxes, and one such source may well be taxes on business.

"Until this question is resolved," writes Mr. Shepherd, "it is premature to expect that Proposition 13 will directly induce increased business investment in California."

prior to this new assignment, John headed his own consulting firm in Plattsburgh, N.Y., where he was also a faculty member of the State University of New York. . . . The National Oceanic and Atmospheric Administration has honored Dr. **Rudolph W. Preisendorfer** with its Outstanding Publication of the Year award for his recently published six-volume work, *Hydrologic Optics*, a study of light in the sea with applications to visibility, biology, and meteorology. Dr. Preisendorfer is a research mathematician currently working with the N.O.A.A. Climate Research Group at the Scripps Institution of Oceanography. The volumes are based on Dr. Preisendorfer's research while with the Visibility Laboratory of Scripps during the period from 1953 to 1969. After 1969 Dr. Preisendorfer joined N.O.A.A.'s joint tsunami research effort at the University of Hawaii where he remained until last year, studying the effects of earthquake-produced tidal waves (tsunamis) in open-ocean and near-shore regions. Dr. Preisendorfer currently is studying long-range weather forecasting, attempting to use statistical methods to predict U.S. mainland temperatures and precipitation a season ahead.

We regretfully report the death of Dr. **Henry J. Albert** of Colts Neck, N.J., who received Bachelor's, Master's and doctorate degrees in metallurgy from M.I.T. Dr. Albert was the manager of services of the Technical Services Department with Engelhard Minerals and Chemicals Corp. He died September 19, 1978.

Dr. **William S. Quigley**, a nuclear medicine physician with the Guernsey Memorial Hospital, 1341 North Clark St., Cambridge, Ohio, has recently been very ill following complications of hydrocephalus valve surgery. Dick has been confined at the Ohio State University Hospital in Columbus since December 17. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif. 94301

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Dave Springsteen left E. F. Hutton a year ago to start his own (David F. Springsteen Co.) financial consulting/corporate finance business based in Greenwich, Conn. The focus is on raising capital and solving financial problems for companies; so far it seems to be prospering, Dave reports. . . . **Jerry Catz** is chairman of the Department of Mechanical Engineering, University of Miami, Coral Gables, Fla. . . . **Ernest Hinck** has been enjoying the past two years as Corporate Director of Engineering for Ingersoll-Rand Co. He was previously Chief Engineer of I.R.'s Portable Compressor Division worldwide. . . . **Val Palmer** was recently named President of Alco-Gravure, Inc., a Macmillan, Inc. subsidiary. His prior accomplishments include Director of Operations at the Chicago Tribune Co., Vice President and General Manager of the New York News, Inc. and a stint in the Navy as a fighter pilot.

According to **Bob Warshawer**, Reunion plans are firming up and scores of classmates have indicated that they plan to attend. A slide show is included in the agenda and *you* are invited to select five or six of your most intersting pictures (preferably 2 x 2 slides) that depict life at Tech "back then." What was it really like 25 years ago!?) Please label them with your name so that they can be returned after the reunion and send them to one of the class officers. The reunion committee is also looking for interested volunteers and nominations for the slate of new class officers. Names are needed to fill class president, class vice presidents, class agent, class secretary, class estate secretary and class treasurer openings. — **E. David Howes Jr.**, Secretary, Box 66, Carlisle, Mass. 01741

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Joe Carleton is with Bacharach Instruments, making detectors for combustible and toxic gas. He and Ruth are active in the Sierra Club and other conservation issues in the Pacific Northwest. . . . **James Stenborg** has been with Monsanto since graduation and last November was named Controller of the Corporate Engineering Department in St. Louis. . . . **Ed Zoolalian** has been with Neff Instruments Corp. for 11 years in Pasadena, Calif., where he is active in local government. . . . **John Seeger** recently completed his doctorate at the Harvard Business School, and last known was seeking a faculty position in the business policy and organization behavior area.

Hal McKittrick has been with the Perini Corp. for 18 years and currently is project manager for a segment of the extended construction of the Washington, D.C., Metro System. He and his wife live in McLean, Va., with their four sons; the oldest is considering several ivy league options for next year. Hal recently completed the six-week management development program at Northeastern University, where your secretary **Warren Briggs** is teaching. — Co-secretaries: **Bruce Budehoft**, 7100 Lanham Ln., Edina, Minn. 55435; **Warren G. Briggs**, 33 Bancroft Rd., Wellesley Hills, Mass. 02181 (617) 235-7436

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I've just returned from an eight-week trip and found the mailbag rather full. So away we go . . . **George Seiler** drops us a note saying: "We have begun Profit Planning Associates, which is engaged in business consulting on profit planning, analysis, and control. This new venture is moving well and going in exciting directions." . . . **Hal Smith** helps us all understand how old we are with the news that his daughter Natalya is a sophomore at Yale and son Peter a freshman at Harvard. . . . And then there are those that are just getting started. **Mel Ginsburg** reports the birth of his second child (and first daughter) on June 6 of last year. Best wishes to Caryn Marie.

Bob Rosin's note is as follows: "I'm still at Bell Laboratories — doing my best to stay out of management and still have some influence. Living near the ocean in central New Jersey is not so pleasant as central Iowa, and we miss living in a university community. Overall we have nothing to complain about." . . . **Theron Bastian** has been appointed to the new position of General Manager, Carborundum Irrigation Systems, the organization that will carry out Carborundum's worldwide strategies in the irrigation field. Theron has been with Carborundum since 1957. He and his family live in Grand Island, New York.

From **Fred Jaggi**: "Since last December I have been working as Director of Project Operations for Procon, Inc., in Des Plaines, Ill. I am responsible for the project management and engineering functions handled by Procon's Des Plaines Operations Office. Our activities include the design and construction of petroleum, petrochemical, chemical, and gas plants. . . . **Selden Saunders** describes the new management responsibilities of himself and his wife as follows: "This year my wife Diana and I have adopted two boys: David Brian, 2½, from El Salvador and Walter Christopher, 6 months, from Columbia." That sounds like a marvelous new job, Selden. Our best wishes.

Howard Resnikoff, who was formerly the Chairman of the Department of Mathematics at the University of California, Irvine, is now Director of the Division of Information Science and Technology for the National Science Foundation. . . . **Uzal Martz**, who is president-publisher of the *Pottsville* (Pa.) *Republican*, was elected president of the Institute of Newspaper Controllers and Finance Officers. Prior to joining the *Pottsville Republican*, Uzal had held positions with the Corning Glass Works and Exxon. He had also served three years as a legislative assistant to the Judiciary Committee in the U.S. House of Representatives. . . . More in May! — **Fred L. Morefield**, Secretary, Aquetong Rd., Carversville, Pa. 18913

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Brrr. Here we are on a near-zero degree day, huddled over the typewriter with frozen fingers because the heating system in our office just

Industrialist vs. Environmentalist: Four Roadblocks to Understanding

Must environmentalists and U.S. corporate leadership be adversaries in constant, acrimonious debate about values and priorities?

The National Coal Policy Project provides at least a shred of evidence that the answer can be "no" — that understanding can replace confrontation between environmentalists and industry, says Laurence I. Moss, '56, a consultant on energy and environmental policy who has been identified with many militant environmental groups. Mr. Moss was Chairman of the Environmental Caucus of N.C.P.P., and he thinks N.C.P.P.'s progress toward policy recommendations on how to use U.S. coal resources exposed some important insights on the anatomy of environmental-industrial confrontations.

Reporting to the 1978 American Assembly of Columbia University last spring, Mr. Moss listed four areas of special difficulty:

— N.C.P.P. sought representatives with both technical and policymaking expertise. There were plenty of candidates from the environmental side, he said, but few from industry; the corporate heirarchy, he thinks, separates technical expertise from policymaking.

— There was nothing but trouble from the Washington representatives of both industrial and environmental groups. The whole idea of N.C.P.P. was to eliminate sources of alienation between environmentalists and industrialists. Mr. Moss attributes the lobbyists' foot-dragging to their sense that eliminating alienation might result in eliminating their jobs.

— Industrial and environmental stereotypes turned out to be different. Environmentalists tend to have confidence in the incentives of the marketplace; industrial people seemed to prefer regulatory solutions with which an individual or institution could be identified.

— Industry's view is often too short-sighted, choosing to embrace minimal environmental objectives when industry's ultimate aims would be better served by a more generous strategy. Mr. Moss cited the example of the Public Service Company of New Mexico, which he said has claimed the confidence of environmentalists throughout the state by moving quickly and effectively on pollution control. The result has been "unprecedented community support" which has made rate increases, capital funding, and new projects far easier than for many other utilities.

Will the non-adversarial example of the N.C.P.P. really work? Perhaps the key problem is the first in Mr. Moss' list, he thinks: Can corporate participants in the project communicate effectively enough with their top managements to assure corporate support? "The acid test is yet to come," Mr. Moss told the American Assembly; but he held out hope that N.C.P.P. could be a pilot for new processes to replace "our present exclusive reliance on confrontation."

Telecommunications in Trouble; but the Government Can Help

The U.S. is losing its leadership in telecommunications.

Our share of the total world market is 5 per cent and falling; meanwhile, this $40 billion market will grow to $60 billion by 1987.

The number of foreign patents in critical areas of telecommunications technology is surpassing those of the U.S.

The U.S. telephone network is the finest in the world and our density of telephones unsurpassed, yet the U.S. exports only 3 per cent of its output in this field.

"Unless we do something to assist our manufacturers in the telecommunications field to compete fairly with our foreign competition, then these industries will follow the trend in autos, steel, shoes, textiles, and other American industrial fields."

This strongly worded warning came late last year from Paul Polishuk, '56, President of Information Gatekeepers, Inc., to members of the House of Representatives' Subcommittee on Communications at hearings in Boston.

The U.S. retains "clear leadership" in only four areas of telecommunications: communications satellites, computers, large-scale integrated circuitry, and the planning, operation, management, and maintenance of large telecommunications systems, Dr. Polishuk said. We are "on a par or behind our competition" in satellite earth stations, applications of direct broadcast satellites, digital switching, digital transmission, land mobile radio, and fiber optics.

In countless fields, U.S. manufacturers compete for sales to state-owned communication systems, and in these cases "foreign governments effectively close out foreign manufacturers," said Dr. Polishuk — "unfair competition" about which the U.S. government does nothing. In these cases, and in too many others, foreign competition is based not on technology or price but on "political, protective policies affecting free trade."

To redress the balance, Dr. Polishuk wants strenuous government action to open foreign markets to U.S. manufacturers and to prevent unfair competition by foreign manufacturers in the U.S. There should be a single organization in Washington, he said, with "prime responsibility to coordinate and develop a unified policy on telecommunications trade." (Trade promotion is now a responsibility of the Department of Commerce, but the government's considerable expertise in telecommunications is in other departments. And "efforts to bring together the commercial trade and technical people to work closely in promoting U.S. interests abroad have all failed," Dr. Polishuk declared.)

failed due to a pipe freezing and bursting. But through snow and sleet, your perspicacious penman presses on to bring the class news. We have only a few items this month. Recently someone asked about the frequency of the '58 class column. Sure enough, when I asked when they had sent any news to me, the answer was "never." My message is: when you write, I write. At this point in most of our careers, there is a lot happening so let's hear from you.

Jim Perrin writes that he is currently employed at Battelle's Columbus Laboratories as a research leader. Recently he traveled around the world on a combination business and vacation trip and made technical presentations in Japan and England. His wife Brenda joined him for two weeks in France. . . . **John Leigh** is a senior mechanical design engineeer at GenRad in West Concord, Mass. . . . **Dan Brand** reports: "I left my position as undersecretary of the Massachusetts Department of Transportation (gracefully — a year before Dukakis lost in the primary) and am now in charge of state and local transportation consulting activities for Charles River Associates in Boston."

Congratulations to **Hans Fritschi** who sent us a note saying, "I just got married (yes — for the first time!) to Joan Schmidt of Wellesley. Joan is working as coordinator of physical education of the Newton schools. We recently bought five acres of lush woodland in Norfolk and plan to build in the spring. I am still working at the Foxboro Co. as a systems engineeer and programmer, designing computer systems for process control." . . . Recently, a mini mini-reuinion occured at Logan airport in Boston when Mary and **Sars McNulty** arrived and were met by Beth and **Al Russell** and your secretary. Sars was in town to do some recruiting for Xerox, while Mary was contacting potential publishers about math curriculum materials she has developed. Al was in town regarding some consulting work for the E.P.A. and I was headed out to Detroit. The bar at the airport may never recover from our onslaught. On that note, we will bid a fond farewell from Boston this month — **Michael E. Brose**, Secretary, 30 Dartmouth St., Boston, Mass. 02116

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As happens after a long drought, it does not merely rain; it pours. The mailbag has filled to the brim and reunion news provides another outpouring.

Starting first on the vocational front, **Seymour Rubenstein** was appointed vice president of the Space Systems Group of Rockwell International. . . . **Meyer Kutz**, after having written eight books, moved to the other side of the desk as editor for professional reference engineering books at Wiley-Interscience. . . . Lieutenant Colonel **George Connor, Jr.**, was given command of a major ammunition plant and storage depot in southern Indiana. . . . **Bruce Hartenbaum** announced the formation of H-Tech Laboratories, Inc., in Santa Monica, Calif., to provide contract research and product development services in the areas of defense, energy, health, and instrumentation.

On the other coast, in Elmwood, N.J., **Elliot Fineman** announced the formation of Cost Free Internal Profit Systems, Inc., for consulting services in operations and internal management

No End in Sight for Minis

The two big markets in data processing between now and 1982 are minicomputers and data entry/terminals, and some "staggering" figures for the marketplace and its growth are associated with that prediction from International Data Corp. of Waltham, Mass. — of which Patrick J. McGovern, Jr., '59, is President.

I.D.C. research turned up two "amazing" figures about data entry/terminals late in 1978: by the end of 1977 there were 1.8 million such devices installed in the U.S. alone, and that number will grow at 17 per cent a year for the next five years: the value of the equipment now in use is close to $9 billion. By 1982 there will be nearly 4 million units in use with a value of $19.3 billion.

But even bigger growth is forecast for the minicomputer business — a "mind-boggling" rate, says I.D.C. Shipments of mini-computers in 1978 were up 34 per cent over 1977 when production was 88,000 units; and revenues were up 38 per cent from $2.7 billion. "This demand for minis will continue for at least the next five years," says I.D.C., which forecasts a "compound growth rate of 32 per cent a year with unit shipments reaching 300,000 by 1982."

But a word of caution about minis: the market is changing. Most of the growth is and will be in add-on peripherals, services, software, terminals, and other component products. The "traditional market" grew only 12 per cent between 1977 and 1978.

systems. Help their backlogs by contacting Bruce or Elliot. . . . **Read Moffett** is now the experimental operations group leader for the Z6S accelerator at Argonne National Laboratory. . . . **Chris Schlemmer** has joined the Midwest Energy Co. in Ohio as vice president with responsibilities for the development of coal by means of coal refining and washing. . . . **John McElroy** was named president of Interactive Data Corp., a Waltham, Mass., subsidiary of Chase Manhattan Bank which provides computer-based financial and economic services.

Jim Hurley reports from Miami that he is the sales manager for Cyclo Chemicals Corp., selling surfactants and would like to hear from classmates in the area. . . . **Herb Priluck** has joined Steffian-Bradley Associates, Inc., in Boston where he oversees major construction projects. Herb formerly managed construction programs of the Massachusetts Bay Transit Authority and other projects in Atlanta and Baltimore. . . . **George Haymaker, Jr.**, was elected a vice president of Alcoa. . . . **Bob McAuliffe** has moved to Ridgewood, N.J., where he is the director of systems and building engineering for American Can.

With kudos to: **Bill Widnall**, associate professor of aeronautics and astronautics at M.I.T., who repeated his world championship in the International One-Design Class sailing regatta this past fall and became the first person to have won this competition four times; **Gerald Kramer**, professor of political science at Yale who was elected to the American Academy of Arts and Sciences; **Donald Adams**, managing director of administrative services of the American Institute of Certified Public Accountants, who received the first Wasserman Memorial Award of the E.D.P. Auditors Association; and **Lynn Sykes**, professor of geology at Columbia, who was elected to the National Academy of Sciences.

The lecture circuit brings news of: **Marv Manheim**, professor of civil engineering at M.I.T., who participated in a coordinated set of programs in transportation at M.I.T. last summer; **Richard Huguenin**, director of the Radio Astronomy Observatory at the University of Massachusetts, who spoke to the Smith College alumnae council in the fall; and **Robin Oder**, research associate with Gulf, who participated in a symposium at the University of Houston on desulfurization technology and fossil fuels.

Recent press clippings have noted the challenge matches between a Control Data computer and international chess masters. The computer chess specialist for the company is **Dave Cahlander**.

Longer backs of envelopes tell us that **William Putt** was recently elected chairman of Maverick Corp. of Hartford, a company which employs ex-offenders, unemployed minority youth and A.F.D.C. mothers as it tries to assist these people in entering the job market by providing real work experience. . . . **John Linderman**, a patent attorney, also located in Hartford, recently finished a term as president of the Connecticut Patent Law Association and serves on local and statewide planning boards concerned with water quality programs. . . . **Bruce Silberg** is currently an intern at Video Variations, a video production firm in Manhattan. . . . **Paul Brown** reports from the Lawrence Livermore Laboratory where he has been for 11 years that he now directs the activities of the computations section of the earth sciences division.

Miguel Colina Marie has returned to M.I.T. as a fellow in the Center for Advanced Engineering Studies. He formerly directed telecommunication activities in Peru and Ecuador. . . . **Elaine Beane** reports from Wayne State University, where she has been teaching anthropology for the past six years and finishing her doctoral work, that son Alex Langford entered Drexel University this fall, where his father **George Langford** is on the materials science and engineering faculty. . . . Our erstwhile Los Angeles to Moscow traveler **George Elbaum** reports on his representation in trade exchanges of scientific instrumentation and oil field equipment. Plan another trip in June, George, but stop in Boston for what promises to be an exciting 20th Reunion!

Almost 100 classmates have indicated they are planning or hope to attend in June. A random pick of twenty planning to come with advice to look to your reunion mail from **Art Collias** for the full list, are: **Bill Bassichis**, **Larry Broutman**, **Oliver Seikel**, **Jan Grondstra**, **Pat McGovern**, **Mike Nash**, **James Schattinger**, **George Bloom**, **John Christie**, **Jack Kossler**, **Mike Drew**, **Joe Mogilner**, **Ken Taber**, **Bob Cross**, **Terry Gildea**, **Don Mott**, **Steve Kaye**, **Peter Moss**, **Helen Christensen**, and **Victor Mashaal**. We haven't heard from **Aaron Rosen** who might have the time to come in since he recently retired (!), spends lots of time with family, relaxes and sells some real estate to keep busy.

You should have received by now the class questionnaire, continuing the tradition started at the 5th Reunion. I have recently uncovered the dusty responses of the earlier questionnaires and we plan to publish all results in time for June. Please fill out yours and return it as soon as possible.

The reunion mail also brought the sad news of the death of **Robert Langelier**, in Falls Church, Va., to whose family we extend our condolences.

I had a note from our overseas correspondent, **Adul Pinsuvana**, who writes from Jakarta of the now two years' experience for him, Malulee and their three children. Their best news is the possibility of making it to Boston in June.

That is all for now. However, when replying to the reunion mailings, take a few extra minutes and send some news to keep the columns filled. — **Phil Richardson**, 180 Riverside Dr., N.Y. 10024; **John Amrein**, 770 Greenwood Ave., Glencoe, Ill. 60022; **Adul Pinsuvana**, ASEAN Secretariat, 6 Jalan Taman Pejambon, Jakarta, Indonesia; **Bob Muh**, 907 Chantilly Rd., Los Angeles, Calif. 90024; or **Allan Bufferd**, 8 Whitney Rd., Newtonville, Mass. 02160

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It was only a matter of time before one of our classmates made it to the *Guinness Book of World Records*, but the event went unheralded for two years. Right there on page 162, it announces that **S. Christian Simonson** discovered the earth's nearest galaxy, 0627+15. It has a mass of 10^8 suns and is 55,000 light years away. Chris left astronomy in 1975 to return to nuclear engineering, recently opening the west coast office of Nuclear Associates International in Sunnyvale. He also mentions recent visits with **Tom Thiele** in Phoenix and **Ralph Cuomo** in Westboro.

In the business world, **Robert McCullough** is vice president for engineering and a founder of Magnuson System Corp., which manufactures computers that are plug-compatible with IBM

Hugh Morrow, '60

units. . . . **Hugh Morrow** has been promoted to manager of technical information for Climax Molybdenum Co., and he continues to serve as editor of the company's technical journal. Hugh holds several patents and has authored numerous papers on high temperature materials. He is chairman of the A.I.M.E. High Temperature Alloys Committee and chairman of the A.S.M. Materials Availability Activity. . . . **Norman Vadner** is manager of administration, organization, and control of Krall Management, Inc., of Radnor, Penn. K.M.I. is a management consulting firm specializing in computer and information systems. Norm is a member of the Association of Consulting Man-

agement Engineers. . . . Since early 1978, **George Koo** has been a vice president of Chase Pacific Trade Advisors, a unit of the Chase Manhattan Bank. The company provides advisory services to companies interested in doing business with the People's Republic of China. . . . **Peter Magnante** has formed Brookfield (Mass.) Instruments Co., which specializes in instruments for measuring low levels of air, water, and petroleum contaminants. Previously a senior physicist and manager of advanced technology products at American Optical Corp. and a staff scientist at Baird-Atomic Corp., Peter also is an affiliate associate professor of physics at Clark University.

Alan Starr is working in the Office of Utility Systems in the Department of Energy. . . . **"Cause" Kemper** has been promoted to lieutenant colonel, U.S. Army, and continues his assignment with the Intelligence and Security Command in N.Y.C. . . . **Lawrence Kravitz** also reports that he still is with the Army; a recent interest of his is to apply quantitative methods to investment analysis. . . . **Bruce Baldwin**, general manager of the New England Telephone Co., is a vice chairman of the United Way of Southeastern New England's 1978 campaign, and he resides in East Greenwich, R.I. . . . **Terry Bower** has been elected vice president of the M.I.T. Club of Boston. — **Robert F. Stengel**, Secretary, 329 Prospect Ave., Princeton, N.J. 08540

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Fame is gradually coming to the Class of 1961! **Kenneth Nill**, who is a co-founder of Laser Analytics in Lexington, Mass., is in the 40th edition of *Who's Who in America*. Congratulations, Ken. . . . Most of us take pride in much smaller victories. For example, **Dick Resch** reports that "last June, after 5 years of running, I completed the Duluth Marathon in 3:25:10 to qualify for the Boston Marathon. This April my wife and two daughters will travel with me to Boston to participate in the 1979 B.A.A. marathon." Very impressive. . . . **Paul Robertson** is into race walking and is writing a regular column in *Running Review*. He has been running and race walking since graduation. Paul's son is following his his father's footsteps (to coin a phrase) and came in third in the East Coast Invitational meet in the "9 and under" age group last fall. Paul finances all of this by consulting in telecommunications with a firm called A.A.I. which will soon be renamed Calculon, in Arlington, Va.

Another of our hale and hearty classmates, **Joe Harrington**, writes that he is into skiing, hiking, swimming, choral music, photography, and keeping tabs on his two pre-teenage boys. Joe is still a project manager for New England Power. In his off hours he is on an M.I.T. Visiting Committee, the Alumni Council, and an Appalachian Mountain Club task force which is keeping tabs on the negociated peace between the environmentalists, the state, and "the feds" over highway construction development long planned for Franconia Notch in New Hampshire. Whew!

Bernie Goldhirsh also seems to be keeping busy, according to my favorite column in the *New York Times*, (the advertising piece), he is the "successful publisher of three magazines at the age of 38 because of his ability to perceive a need and then fill it." His latest magazine is called, simply *Inc.* and is designed for small business owners. Bernie works on Commercial Wharf in Boston. The other magazines started by this wonder are *Sail*, *Motorboat*, and *Marine Business*. (See *Technology Review*, February, p. B14.) This column is beginning to get me down. Aren't there any failures out there? Apparently no.

Curt Hartwig writes that he has been working with the local chapter of S.C.O.R.E. (the Service Corps of Retired Executives). He goes on : "As an A.C.E. (Active Corps of Executives) volunteer, I have learned a lot about the problems that small businesses face today. I have just joined the General Electric Co. in Binghamton, N.Y., as Development Engineer. Last fall I was elected secretary-treasurer of the Southern Tier Chapter of the A.C.M., and I am competitions chairman for the slide division of the photo center at the Roberson Center for the Arts in Binghamton. At home, I have become fascinated with the hobby computer craze. Now if I can just figure out what to do with the thing!" Thanks for the note, Curt.

Also interested in the small business side of life is **Andy Zeger** who is now in his second year at Zeger-Abrams, Inc., a company working the field of adaptive antenna arrays and interface cancellation systems. . . . **John Carson** is a self-made businessman having been a co-founder of Carson Alexion Corp., a company involved in electro-optics research and development. They work primarily in infrared surveillance from space. They recently set up a subsidiary in Sudbury, Mass., called the New England Research Center. . . . **Dan McConnell** is happy in his nitch at Amana Refrigeration, Inc., as Senior Vice President for Sales. He, his wife Betsy, two girls, three boys, two dogs and two cats are content and happy in Iowa City, Iowa. . . . **Al Brennecke** is in Detroit working for Burroughs, a manager of contracts in the international group. He reports that his responsibilities will be Europe and Africa.

Some of our M.D.s are reporting in. **Richard Stifler** writes that he is in private psychiatric practice in Wellesley, Mass. The Stifler family includes his wife Linda, a son Timothy (5), and a daughter Emily (4). **Bill Jouris** is farther afield. He writes: "I am just about to begin my third year of employment at the King Faisal Specialist Hospital and Research Center here in Riyadh, Saudi Arabia, as head to Gamma Irradiation Services. The Gamma facility should finally be installed this next year as the Cancer Research Institute is nearing completion. I would love to hear from any alumni in Saudi Arabia." . . . **Irwin Sobel** is a senior research associate in biological sciences at Columbia University. He is applying computer vision methods to serial sections of nerve cells. He married Ceeval Ann Freedman (of Durham, N.C.) back in 1971.

Thank you for all the letters and notes. All you successful people out there just keep sending me the clippings and you failures keep reporting on other aspects of your lives. Keep in touch. — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

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I have a good batch of notes from you this month — mostly Alumni Fund flaps, and many from regular correspondents. I have been doing this job for almost six years, and I've noticed patterns to the notes you write. I must say that I look forward to the annual correspondence I get from some of you (even if it's not directed to me personally). But the news notes from sporadic contributors are also a pleasure — like letters from long lost friends. Let's have some more communication from those of you whose news has not appeared here.

The first two items concern classmates who are pursuing medical careers. **Alan Marty** writes that he has helped start a new cardiac surgery program in a rural area of southern Indiana. "Small is beautiful!" says Alan. He has also been elected as a fellow of the American Colleges of Surgery and Chest Physicians. . . . **Georges Duval** has nearly finished medical school at George Washington University, and he will begin internship in surgery at Bethesda National Naval Medical Center in July, 1979. He writes that his wife and children are still doing well despite the lack of financial support from the man in the family.

Henry Nau is also at George Washington, where he is an associate professor of political science and international affairs. Last summer he travelled to Japan and Latin America as part of a study he is doing on energy politics in the U.S., Japan, and Mexico. . . . Moving on up the coast to Morris Plains, N.J., we find **Robert Rabiner**, his wife Marlene, and son Mark (age 3). Bob is working for Data General as a sales engineer. . . . Still farther north, in Lexington, Mass., are the **Steven Bernsteins**. Steve, his wife Stephanie, daughter Debbie, and son David, are long-time Lexington residents. Steve is a group leader at Lincoln Laboratory. He writes that he enjoyed going to Europe last summer to present a paper at a N.A.T.O. conference on satellite communications.

From the other coast, **Tom Anderson** writes that he is running Electric Technology Corp. (which manufactures electrical transformers and bus bar systems) and developing a line of land reclamation products. Tom is living in Tacoma, Washington, with his wife Kitty and daughter Erin. . . . **Larry Kazanowski** is presently director of the Technical Environment Evaluation Office at Ford Motor Co., where he has been since receiving his M.B.A. from Stanford. His wife, Cara, is editor of *Ford Times* magazine. The Kazanowskis have a baby girl, Kristin, who is rapidly approaching her first birthday. . . . **Ed Dudewicz** was co-author of a paper which received the 1977 Shewell Award for excellence at a fall 1978 Technical Conference of the American Statistics Association and American Society for Quality Control.

A short note from **William Pettus** informs us that his son, William Hamada Pettus, was born August 8, 1978. . . . **Ted Packard** writes that he is still working in oceanographic research, mainly on the Peru Current upwelling ecosystem, but also to a lesser degree on the Pacific equatorial upwelling. He works at the Bigelow Lab, and lives in Boothbay Harbor, Maine, with his second wife, Dolores, who is also an oceanographer. The Packards are expecting a child in April. Ah, Boothbay Harbor — I have fond memories of a long weekend there in June, 1963, just before graduation. Lovely, lovely spot.

And, finally, I have my annual note from my old high school and course VIII compatriot, **Bob Yaes**, who lets us know that he is still unemployed. On that note, I will close for this issue. — **Mike Bertin**, Secretary, 18022 Gillman Street, Irvine, Calif. 92715

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Year-end Alumni Fund contributions gave a bonus of lots of news. **Mark Hanson** has left Digital Equipment Corp. to join Arthur D. Little, doing case work on data base designs and interactive computer systems. . . . **Tom Van Vleck** is still working on MULTICS for Honeywell, but is now doing this in Phoenix and has sold his trusty Porsche. . . . **Steve Lipner** has returned to MITRE in Bedford, Mass., from Germany. . . . **Tom Ostrand** is a senior computer scientist for Sperry Univac in Blue Bell, Penn. . . . **Bruce Golden** had an article published in the *Banking Law Journal* of October 1978.

Ron Brinkerhoff is a research and development engineer with Senco Products in Cincinnati; he built his own house and is doing some teaching. Ron is now divorced. . . . **Walt Miller** is an Assistant Professor of Pediatrics at University of California in San Francisco, where he is cloning genes for hormones by recombinant DNA techniques. Walt has become a ski fanatic. . . . Susan and **Philip Smith** and their two daughters have moved to Madison, on the Connecticut shore, where Phil is President of the Kupler Corp., a manufacturer of electrical hardware. . . . **Stephen Deutsch** continues to practice law in Boston with Foley, Hoag and Eliot; Steve and Karen and children Nancy and Jeffrey spent some time last summer in the Colorado mountains. **Henry Lichstein** returned to New York from Nairobi in January, 1978, to become Financial Controller of Consumer Services for Citibank. The Lichsteins are now living in Scarsdale with their 5- and 7-year-old sons. . . . **Alan Schutz** was recently promoted to Associate Division Leader of the Electronics Design Division at Draper Labs; 1978 saw the birth of the Schutzs' third son, David Alan.

Stephen Loutrel is Director of Engineering for Navtec, designing marine rigging and hydraulics; last summer the Loutrels, including 2-year-old Laura, spent two months cruising in Newfoundland. . . . **James Elliot** has returned to M.I.T. after six years at Cornell, to be Associate Professor and Director of the Wallace Astrophysical Observatory. . . . **Eric Westerfeld** is Manager of Advanced Hardware Systems at Four Phase Systems in Cupertino, Calif.; the company is

Architect Turned Quiltmaker: Opting Out of Compromise and Frustration

"You graduated from M.I.T.?"
"Yes; in architecture."
"What do you do now?"
"I help my wife make quilts."
That conversation with Jeffrey D. Gutcheon, '66, is fictitious — but not very.

For Beth and Jeffrey Gutcheon are quiltmakers, authors of *The Perfect Patchwork Primer* and now *The Quilt Design Workbook* (New York: Rawson Associates Publishers, Inc., $12.95). Their first book was described by the *New York Times* as "a Bible for those interested in this craft," and their second one by its publisher as "a workbook that takes the guess-work out of patchwork." Their books have brought the Gutcheons national fame; they are "among the best-known of contemporary American quilt-makers," says the publisher's "pitch" for their most recent book, and their quilts have appeared in many exhibitions in the U.S. and abroad.

How did it happen?

Mrs. Gutcheon explains in the foreword to their most recent book. Jeffrey "loved design — doing it, teaching it, and talking about it," she writes. But after several years in architectural offices he realized that "the realities of working as an architect had very little to do with designing and a great deal to do with compromise, frustration, and almost unendurable delay. . ."So he determined to become self-employed, as pianist and designer.

Meanwhile, Mrs. Gutcheon had a "primitive urge to make things," and presently she found that quiltmaking "meant more to me than any other craft. . . . I came to feel that American quilts are not just a series of artifacts but an important part of the history of American women. That their beauty, their ingenuity, and also the vast amount of repetition. . . in some important way constitutes a record of what life has been like for American women."

Mr. Gutcheon's interest in quilts followed when "he realized that designing a quilt was not unlike other kinds of design he had been trained for, and making a quilt was not unlike building a chair," Mrs. Gutcheon writes. As the Gutcheon's books make vastly clear, quiltmaking offers plenty of rather unique opportunities for designers. — *J.M.*

involved in large distributed data processing systems. **James Falender** presented a paper on rubber chemistry at the October meeting of the American Chemical Society. . . . **David Lerner** sends his regards to classmates; he will be running in the Fiesta Bowl Marathon this year. . . . **Greg Schaffer** got in some rock climbing while attending the Alumni Officers Conference last October. . . . **Peter Addis** is a computer software consultant at Gibson Engineering in Norwood, Mass., working with microprocessors. . . . **Ronald Newbower** received an award from the Instrument Society of America for designing an improved electronic tympanic thermometer. . . . Finally, **Steve Kaiser** is alive and well, and still drawing "tech tools." That's it for this issue. Keep those cards and letters coming, fans. — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, Mass. 02181

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There is a plethora of correspondence this month. We hear from **Stuart Shapiro** that he is currently an associate professor and acting chairman of the computer science department at the State University of New York at Buffalo; his wife Caren is an assistant professor of biology at D'Youville College in Buffalo. Stuart is leading the Buffalo area alumni as president of the M.I.T. Club of western New York. . . . **Gerry Lichtenberger** is continuing to manage the operations of Xybion Medical Systems Corp., a subsidiary of Xybion which he co-founded three years ago. That means Gerry has advanced in that time from informations theory applications in sonar to developing CLINFO, a clinical data analysis and management minicomputer system. I, too, have made the transition to medical information systems although I am a cog in a wheel instead of a corporate magnate. So far I have not had the resourcefulness to dream up an obscure company name like Xybion or AMREC.

Jeffrey Schwartz was recently promoted to professor at Princeton University. . . . **Tom Jones** is on sabbatical from the Colorado State University electrical engineering department and is at G.E. in Schenectady. Tom and his wife welcomed their second daughter, Audrey Katherine, into the world on August 31. Congratulations! . . . Having just mailed in my application to run in the Perrier Cherry Blossom Classic ten-mile run here in D.C., I offer special encouragement to you all to patronize the new book by **John Schwanbeck** and his wife. It is *The Traveling Runner's Guide* by R. P. Scheerer and J. R. Schwanbeck (E. P. Dutton, November, 1978). It is a paperback describing where to jog in 21 cities in the U.S.A. and is designed for the traveling business or professional person who wants to conveniently maintain an exercise schedule. It includes descriptions of routes, maps, sunrise/sunset times, etc.

Berry Skeist has accepted a position in the Department of Radiology of the Hospital for Special Surgery in New York doing skeletal radiology. He is also an assistant professor at Cornell Medical College. . . . **Jonathon Hopkins**, after having taken an M.D. at Cornell, is finishing up a residency in neurosurgery at the University of Michigan. . . . **Peter Young** is rising in the bureaucratic ranks of Pennsylvania; he is Assistant General Manager for Planning and Development of S.E.P.T.A. — (Southeastern Pennsylvania Transportation Authority) over a staff of 70-plus persons. . . . **Roger Rasmussen**'s two-year-old twins, Paul and Carolyn, are keeping his life fun-filled and eventful. He currently is Associate Director of the Independent Analysis Unit, Los Angeles Unified School District.

Peter Lobban enjoys being an electrical engineer at Varian Associates. . . . At the other end of the country **Richard Leslie**, in Freeport, Maine, has moved from Internal Consultant to Marketing Systems Manager at L. L. Bean. . . . **Forrest Stoddard**, a longtime Course XVI holdout, has just received his Ph.D. in ocean engineering at the University of Massachusetts, Amherst. He is continuing along the lines of his thesis project by working at Windpower Associates in Burlington, Mass. His thesis title was, "Structural Dynamics, Stability and Control of High Aspect Ratio Wind Turbine Generators."

Paul Godfrey, M.D., wonders what has happened to his confreres from M.I.T. days and particularly asks "Woody" to speak up and be heard from. Paul has joined a 15-man medical group as one of two surgeons and has found a very successful practice in San Bernadino, Calif. **Woody Sullivan** responds that he has been promoted to Associate Professor of Astronomy (University of Washington) and is actively involved in radio astronomy research on galaxies as well as other wild things (see *Science*, January 27, 1978). He has a daughter Rachel born in 1977 and invites all Sig Ep's to stop in for a visit if in Seattle.

Martin Kaliski continues in the Boston area as an associate professor of electrical engineering at Northeastern University doing research in one-dimensional iteration theory. . . . Lastly, **Saul Mooallem** continues the aiding and abetting of computers in our life by becoming a sales representative for Control Data Corp. in the New York district. Saul and his wife Susan helped their daughter Rebecca celebrate her third birthday in November and look forward to the same for their son Jonathon's first birthday this coming June 24.

Do keep the news coming and remember you can correspond with your friends through this column. 'Til next month — **J. Patterson**, 1403 Gerard St., Rockville, Md., 20850

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Joan and **Bruce Barron**, who left southern California because they felt it was turning into another New York City, have moved to the Phoenix area where Bruce is an engineer with Sperry Flight Systems designing computers for space applications. They wonder why they did not make the change sooner. . . . **Chuck Greene** recently spent three weeks in Israel researching a screenplay. He plans to move to Los Angeles from Toronto. . . . Last March **Paul Caragine** married Elise Ruth Lawrence (Washington College, Md., '74) whom he met when he operated as a resident on her knee. He is in his third year of private practice as an orthopedic surgeon in his hometown of Boonton, N.J., and is the school physician for the Boonton schools.

After working at Spacetac, Inc., since graduation, **Don Mattes** switched jobs last year to join Andover Controls Corp. where he is in charge of the solar energy group. The company has more than doubled in size since he's been there, going to 22 employees. . . . **Henry Radzikowski** works for I.T.T. in Brussels, Belgium. He and Bridget, from Austria, were married last summer. . . . **Roy Gamse** is still deputy assistant administrator for planning and evaluation at the Environmental Protection Agency. His wife Joyce works at the Library of Congress Publications office. . . . **John Child** works at Synnestredt and Lechner, a law firm specializing in patents, trademarks, and copyrights.

Mark Fineman has been relocated by D.E.C. to Merrimack, N.H. . . . Sara and **Mark Goldman** have their second child, Elizabeth, born October 29, 1978. Mark is on the cardiology staff at Massachusetts General Hospital. . . . **Pete Denton** reports that business is good in the high vacuum industry. Denton Vacuum is making a major effort in producing optically invisible glass for picture framing; their glass is in use in the National Gallery and the Smithsonian. . . . **Alan Hayes** is a consultant to Burroughs in Utah. He made it back to M.I.T. a few months ago and visited **Gary Garmon** and his furniture factory and 1720 vintage home in Groton — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

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Greetings again from the sunny banks of the Potomac River. As if our 10th Reunion was not enough to make us think it's been a long time since graduation, we recently had several current students stay overnight while visiting D.C. as part

of I.A.P. activities. Alas, many things we remember about the 'Tute are already ancient history. Fortunately, the quality of the students and the education they receive continues to be high.

I recently returned from a one-week visit to the Naval Postgraduate School in Monterey, Calif., where I lectured on command and control problems at the invitation of Jack Wozencraft, Sc.D. '51, formerly of the M.I.T. faculty, who now heads the school's command and control program. I was also pleased to see again Lt. Col. Roger Schell, Ph.D. '71, who is teaching computer systems courses there. . . . From the south we hear that **Paul Gluck** has a private practice in obstetrics and gynecology in Miami and is a clinical instructor at the University of Miami School of Medicine. He recently co-authored a publication with his wife Joan, a practicing allergist, entitled "Pregnancy and Asthma" that won a first prize in the national competition of the American College of Allergists. They are both enjoying the "sun and fun" in Miami, especially the Miami Dolphins.

Bob Phair has a lot of news to report. He finished his Ph.D. in November, 1977, three months after Judy, and he bought their first house. In August 1978 he finished his first postdoc and began a second on the mechanisms of insulin and glucagon secretion while simultaneously beginning a job search. This July he will start as assistant professor of physiology at the Johns Hopkins University School of Medicine. . . . Laura and **Armen Varteressian** had their first child, Roxanne, on November 27, 1978. Armen adds "Thank God the baby has her mother's looks." . . . Last spring **Mike Krashinsky** was promoted to an associate professor and given tenure at the University of Toronto (Scarnorough College). In the fall he published his first book on the economics of day care, a practical topic since he has two children — Harry (4) and Jonathan (2). . . . **Dave Seldin** reports that his youngest child Miriam is now one-and-a-half and thinks she's a real grownup. Jeffrey (4) and Shana (3) are both in nursery school which they are enjoying. Dave is finishing a radiology residency at N.Y.U. with a fellowship in nuclear medicine and will soon be looking for a job. . . . Upon graduation, **Steve Passage** went to the Big Apple to work for the Port Authority of New York and New Jersey, expecting to stay for one year. Ten years later he is still there enjoying his job in the field of resource recovery, trying to recover energy and materials from garbage. . . . Finally, we hear that **Dan Green** is a research assistant professor in the Department of Pediatrics, State University of New York at Buffalo. . . . That's all we have for this month; we'll see you again in May — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

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Dr. **Sharon Grundfest** sends word that she has completed her residency in general surgery at the Cleveland Clinic and is now a special fellow in colon and rectal surgery. On June 18, 1978, Sharon married Dr. Michael Broniatowski, a specialist in otolaryngology, from Paris, France.

Forbes reported on July 10, 1978, that **Tom Scholz** and his group "Boston" have sold more than six million copies of their album. Along the way Tom purchased a modern recording studio for use by Boston and other groups. *Forbes* quotes Tom as saying: "What began as a hobby started to become an obsession with me. I had always worked hard to get through M.I.T. and then at Polaroid. But I found I was dissatisfied." Best of luck with the second album.

Steve and Marilyn Zayac announce the birth of their second daughter, Elise Mei, on July 5, 1978. Steve is with Ford Motor Co. and Marilyn is teaching and consulting.

David A. Cane is a principal engineer with D.E.C. in Tewksbury, Mass. The Cane family had an addition in May, 1977, when Rebecca, a second daughter, was born. . . . **Christopher W. Brooks**, Manufacturing Systems Manager at Schramm, Inc., has earned the title of Fellow in the field of production and inventory control of the American Production and Inventory Control Society. To become a fellow, Christopher had to pass four of a possible five written examinations administered by those friendly folks in Princeton, N.J., E.T.S. A.P.I.C.S. has over 22,000 members in North America. . . . I am saddened to learn of the death in 1974 of **Elpidoforos G. Ipiotis**, Course XX, of Athens, Greece.

I hope we'll have a brighter ending next time. — **Peter Peckarsky**, Secretary, 950 25th St., N.W., Washington, D.C. 22037

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The field of law has claimed further classmates. **Edward Chalfie** joined a firm and practices patent and trademark law in his hometown, Chicago. . . . **David McIlwain** writes that he is a lawyer in New Hampshire and litigates only in the area of computer contracts. . . . After receiving a Ph.D. in mathematics from R.P.I., **James Widtefeldt** pursued a J.D. from the University of Nebraska's College of Law and now practices in O'Neill, Nebraska. . . . **David Saar** is presently manager of the advanced electronics group at Black and Decker but may be in the field of law after his bar exams and graduation from the University of Maryland. . . . **Roderick Walker** is also in Chicago as a vice president for American Management Systems. He says business is growing at a rate of 50 per cent per year — up to 40 million dollars.

I received a letter from Barney Black '71, who enclosed a copy of a postcard from Kurt Klinzing '71. Kurt has been traveling in Europe and Asia, but now has headed for Egypt and a trip up the Nile — "because it's there." . . . **Russell Glisker** left Index Systems of Cambridge, Mass., after eight years. Ellen accompanied him to Westport and he is Vice President of Technological Planning and Development for the Pershing Division of Donaldson, Lufkin and Jenrette Securities. . . . Another classmate changing occupations after a long period, seven years, was **John Gerth**. He left the mountains surrounding Virginia Tech and its College of Architecture Computing Center for the I.B.M. lab in San Jose.

Tony Rufolo has embarked on new adventures while working in the research department of the Philadelphia Federal Reserve Bank. These include buying a house, helping Pat with their twin girls and teaching at the University of Pennsylvania. After completing residencies in internal medicine and dermatology, **Wayne Porter** received board certification and is in private practice in Miami. . . . **Jim Brasunas** is still endeavoring to be an ornamental blacksmith. . . . **Curt Haag** was promoted to senior director of fleet planning and economic analysis for Hughes Airwest. He had been in planning and economic functions since 1972. . . . **Carl Yankowski** is maintaining his home in Stamford while working as Director of Marketing Programs for Pepsi-Cola in Purchase, N.Y. — **Robert Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Ft. Wayne National Bank Bldg., Ft. Wayne, Ind. 47802

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One of the best parts of writing the class notes is being able to let everyone know my good news: my wife and I are the proud parents of a boy, Theodore Clark "Ted" Moorman. We took LaMaze courses which are a great help in understanding the birth process; Lucy's delivery and labor were quick and trouble free. No one can adequately describe the joy of holding your own child, so if you don't know yet I will let you experience it for yourself.

Dan Lynch is a professor on the faculty at Dartmouth in water resources management and hydraulic systems modelling at the Thayer School of Engineering. Dan received his M.S. and his Ph.D. in C.E. from Princeton along with his M.S. and B.S. in M.E. from the 'Tute. Dan has been a research hydrologist for the Water Resource division of the U.S. Geological Survey, research assistant at the World Bank in the Office of Science and Technology, and a consultant to the

How Yogurt from Beta Theta Pi's Bathtub Is Going "Big Time"

When you see the Sundance brand of yogurt at your friendly supermarket or health food store, think of Stephen W. Bishko, '68, and the Beta Theta Pi house.

Because that's where "miracle yogurt" got its start.

Mr. Bishko and some of his fraternity brothers started making yogurt in the bathtub, using reconstituted powdered milk, some butter fat, and hot water. Production grew to as much as 4,000 quarts a week, and the young entrepreneurs figured their profits came to $6 or $7 for every hour they invested in the business.

It was called "miracle yogurt," Mr. Bishko recalls, "because everyone said it was a miracle it tasted so good."

Six years after he graduated Mr. Bishko found himself thinking longingly of the yogurt business; where else, he remembers asking himself, can an entrepreneur set himself up in a simple, lucrative business for a mere $10,000 in start-up costs?

The idea was irresistable, and the next thing he knew Mr. Bishko was president of Sundance Brands, Inc., producing yogurt in 1,500 square feet of space rented from the Sunshine Dairy of Sherborn, Mass. That was in 1975, when Sundance produced some 450 quarts of plain yogurt a week.

Today sales are between 4,000 and 5,000 quarts a week, with a gross take of about $3,000 a week, and the business is breaking even and on the verge of a new move toward the "big time," Mr. Bishko told Ken Tokarz of the *South Middlesex News* in a recent interview.

So far, Sundance has been a "purist's" yogurt — sold only in quarts, in natural flavor, a form which appeals to customers who are "more economical and health-minded," says Mr. Bishko. Now there are plans for smaller containers and specialty items like raisin-date-walnut yogurt — an effort to reach for the "snack-food-eaters." And there may soon be a distribution contract with a "large" supermarket chain.

Sundance's objective, Mr. Bishko told Mr. Tokarz, is "to grow to 20 times the size we are now — as fast as we can." But he won't do this by compromising the product, Mr. Bishko says, and he can't do it until some legal entanglements concerning licensing restrictions and production methods are resolved. And he insists the basic philosophy is — yes, to make a profit, but not to emphasize "maximization."

Maryland Water Resources Administration. Since joining the Dartmouth faculty, Dan has developed a teaching program in water resources and a research program covering system dynamics modelling of the development of low-head hydropower in New England, modelling of snowmelt and runoff, finite element methods in engineering applications, and estuary and coastal zone modelling. The Dartmouth bulletin failed to mention that Dan is an excellent banjo picker and a great person.

Donald Estes writes: "Finally able to move back to New England if not all the way to Boston yet; I plan to spend two years working in the New York City area before returning full time to graduate study in psychology. . . . **Art Gershkoff** will be beginning his residency in Rehabilitation Medicine at Thomas Jefferson University Hospital in Philadelphia. . . . **Robert Wilson** is working for Charles River Associates and raising Polish sled hounds as a hobby. . . . **Timothy H. DeCook** writes: "I am currently in my second year of anesthesia training at Mass. General. Still living in Salem, Mass., but haven't seen any witches on my way to work; my wife, Beverly, reports no broomstick activity either on her daily ride to Danvers where she is employed." . . . **Donald T. Black** is a patent attorney for AMAX, Inc. in Greenwich, Conn., and has bought a house in Darien, Conn. . . . **Henry C. Stern**, formerly doing consulting work with T.M.I. Systems Group in D.C., has moved back to Boston and is with the Information Services Division of Fidelity Management and Research Co., a mutual fund. . . . **Raymond M. Kwasnick** is still an attorney with Guterman, Horvitz, Robin and Pudman in Boston and is a homeowner in Newton. His brother, Robert is pursuing a Ph.D. in physics at the 'Tute. . . . **Marc Roddin** was in Bolivia this summer on a site location study for a petrochemical plant. His current hobbies are: gardening, Italian cooking and disco dancing. . . . **Doug O'Shaughnessy** is teaching at McGill University in Montreal and engaged in research at Bell Northern.

Leonard Tower, Jr. is enjoying life in Boston, planning trips to Tennessee for Christmas and Europe for the summer. . . . **John Malarkey** recently left his position as design engineer for Bechtel, Inc., in San Francisco and is a marketing manager for Occidental Petroleum Corporation in solid waste resource recovery division. Living in Hunington Beach now, close to the water, but he has little time to enjoy it. . . . **Barbara Moore** graduated from Harvard Law and is with the distinguished firm of Hale and Dorr in Boston.

The response this time was great; please write about yourself and classmates as time allows. — **R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Texas 77833

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Welcome to another edition! **Dale Flanders** is a staff member of the M.I.T. microelectrics group at Lincoln Labs in the Submicrometer Fabrication Technology program. . . . **Mitch Reff** received a Ph.D. at Stanford in 1976, married Miyo Tanaka in October, 1977, and currently works as a postdoc fellow at Children's Hospital in Boston. . . . Phyllis and **Glenn Sharfin** have their first child, Andrea Lynn, born November 9, 1978. Glenn is an orthopedic resident at Nassau County Medical Center, along with **Mitch Kaplan**, in surgery there. . . . **Will Cummings** is still alive and well.

Louis Stuhl received an N.S.F. fellowship to do research in the homogeneous catalysis of carbon-carbon bond formation and cleavage. Gee, I love that kind of talk! . . . **Paul Battaglia** works as assistant manager of neighborhood revitalization for the Buffalo Urban Renewal Agency. . . . **David Moylan** will complete his second year of residency in internal medicine this July and begin a fellowship in radiation oncology at Thomas Jefferson University Hospital in Philadelphia. **Tom Wheeler** received a Ph.D. in biochemistry at Brandeis and is now a postdoc fellow at Cornell.

Yours truly is being shipped off to Dallas by Electronics for Medicine come April. My new address will be coming when available. I'm off now to visit **T. Scandora** in Chicago if I can find it under all that snow! . . . Write! — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

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Remember our class reunion on June 8-10. If you did not receive the first letter announcing it, write **Ron Kuppersmith**, 965 Whipple Rd., Tewksbury, Mass. 01876. In fact, by now you should have received a second letter detailing the reunion activities. Be sure to get all the info and be sure to come. Now, the news.

Andy Elliott writes: "I've taken up bicycle racing to stay sane in Oklahoma (they don't crew here) and will be going to Cycling Team Training Camp at the Olympic Training Center in Colorado Springs." . . . **Dave Humsey** is still in Cambridge consulting for T.M.I. Systems Corp., a financial consulting and systems development firm. . . . **Elizabeth Bagnell** is a research engineer in the Industrial Chemicals Group of F.M.C. Research and Development. . . . **Yvonne M. (Walkowski) Perlmutter** has changed jobs and is currently working for MITRE Corp. in Bedford, Mass.

Fred Shapiro writes: "I am organizing a Harvard Tiddlywinks Team. If any reader wishes to join the M.I.T. or Harvard teams (no affiliation with either university is required), he or she should write the M.I.T. Tiddlywinks Association, Small Activities Office, Student Center, M.I.T."

Eve (Bookspan) and **Irwin Hollander** are pleased to say their son Pesach Shmuel celebrated his first birthday on December 11. Eve is now a full-time mother while Irwin is still pursuing his illusive Ph.D. in biochemistry at M.I.T. . . . **Ed Bissett** received his Ph.D. in applied math from Caltech in June and is now working in the math department of General Motors Research Labs in Warren, Mich. . . . **Jay Krone** is now an applications engineer with Teradyne, Inc., in Boston. Jay is still active with WTBS-FM, the M.I.T. radio station; for two years he was program director and is now technical director of the station.

Mark E. Davison writes: "I've finished a math Ph.D. at U.C., Berkley, and am moving to Paoli to start work with Daniel H. Wagner Associates in January." . . . **Mark Robison** is a programming consultant for a small consulting firm in central New Jersey and would love to hear from people in the New York/New Jersey area. . . . **Alan Efromson** is now working at Millipore Corp.

William D. Kingery writes: "I graduated from Syracuse Law School in June, 1978, and am at N.Y.U. for the L.L.M in tax law. I became a father to a girl, Jessica, November 12, 1978." . . . **H. Gordon Deen** is presently interning at the naval hospital in Portsmith, Va. and will begin neurosurgery residency at the Mayo Clinic in July. . . . **Richard Grandstein** is now halfway through his internship at Harbor-U.C.L.A. Medical Center. . . . **Guy Consolmagno** received his Ph.D. in planetary sciences from the University of Arizona in April and is now working as a post-doc at Harvard College Observatory, S.A.O. Center for Astrophysics.

Jim Gokhale has changed jobs and is a superworker at Data Resources, Inc. in Lexington, Mass. When I saw him last month I got a chance to speak with **John Tierney**, who has a fancy house in Southborough, Mass., and will be bringing his entire family to the class reunion in June.

S. Jeffrey Rosner writes: "In early 1975, I left for the West Coast. After many months of traveling on my motorcycle, I have settled here in San Francisco. I have worked on disk drive development for Univac for three years and will start a new job at Hewlett-Packard the first of 1979." . . . **Mark Cohen** writes: "I am presently an intern in the Department of Pediatrics at the University of Michigan Affiliated Hospitals. My wife Jennifer is an intern in the Department of Internal Medicine. After four years of medical school at Columbia in New York City, we are happy to be in Ann Arbor." . . . **Jeffrey Weinreb** writes: "I graduated from Mount Sinai School of Medicine in June afer spending three months in Egypt and Israel and am now an intern at Long Island Jewish Hospital in New York. Next year I will begin a residency program in radiology."

Dallas Helen Abbott writes: "I went to sea twice this fall, once to the Mariana Trough west of Guam and once to the Nores Abyssal Plain south of Bermuda. On the way back from Guam we stopped on Hawaii to look at Kilaweha. I took lots of pictures of the unearthly looking landscape. I plan to bill them as 'Mordor' pictures. Oh yes, I got my masteer's degree from Columbia this fall." . . . **Rajenda Y. Shah** writes: "Since February of 1977 I have been with Data Resources, Inc. in Lexington, Mass., involved in the murky world of economics-management consulting. My group's mission is to help chemical companies make investment and inventory decisions." . . . I regret to report the death of **Gary Q. Louie** of Brooklyn, N.Y., September, 1978.

During the last reunion committee meeting, I had a chance to speak with some of our classmates about what they are doing. I didn't take notes so I forgot most of what they said. So you will just have to come to the reunion to find out for yourself. Another good thing about the class reunion — you elect a new class secretary/treasurer (and president and vice president). — **Dennis Dickstein**, 17 Forest St., #21, Cambridge, Mass. 02140

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Lots of news this time! **Jim Demers** wrote to say, "I'm still slaving away at Stanford, hopefully looking to a Ph.D. within a year. Johnhill, MacGregor H's rabbit-loving Virginian, has recently moved out to this area; he dropped in for a visit — then vanished once again. Despite the perpetual poverty of graduate life, I'll get in as much skiing as possible (as usual) this winter. "Turkey Power Lives!" . . . **Allen E. Bale** is in his fourth year of medical school at the University of Massachusetts and also is presently serving on the M.I.T. Educational Council. . . . **Greg Rothman** is a fourth-year student at New York University School of Medicine. He'll be doing a residency in internal medicine somewhere in N.Y.C. starting July 1, 1979. . . . In a nice note, **Matt Farber** let me know that he will be graduating this June from New York Medical College. Although he doesn't know where he'll be doing his internship yet, he'll start his ophthalmology residency in July, 1980 at the Cullen Eye Institute at the Baylor Medical Center in Houston, Tex. His wife, Sharon Glazier Farber (Brandeis '76) will spend her last year of medical school taking electives in Houston and will graduate from N.Y. Medical College in 1981. They are looking forward to the sunnier warmer winters down south. . . . **David Dinhofer** is currently in his third year of medical school at Tulane University in New Orleans. . . . I spoke to **Peter Dinhofer** on the phone a couple of weeks ago when I was in New York. He also attends medical school at Tulane but he was doing a short stint in radiology at a Manhattan hospital. The reason I got to talk to Peter was because he was visiting **Betty Spiess** at Columbia University with whom I got together later that evening and proceeded to paint the town, west and east sides, in true Six West fashion.

Brian Lustbader graduated from Columbia Law School in May, 1978 and married a fellow law student, Rachel Ostow on September 17, 1978. He is now working at the New York law firm of Rosenman, Colin, Freund, Lewis and Cohen. . . . **Andrij R. Neczwid** moved to Illinois in 1976 where he joined Motorola, Inc. He is now a Senior Engineer in their Data Systems Research Lab, working on multi-microprocessor systems and digital speech processing. He married his Ukrainian wife in October, 1977. She is a practicing opthalmologist. They live in Arlington Heights, Ill. . . . Ever since going to Berkeley over four years ago, **Tom Schnetlage** has been living in a collective/commune/extended family that once went under the name of Harrad West and is now called Goodlife. They're very active in local organization of communes. Tom went to the masters program in City Planning at the University of California at Berkeley for two years. Since then

he's worked primarily at Dombusch and Co., Economic Planners, studying BART and air pollution at Lake Tahoe.

Richard J. McCarthy is a management consultant in the Energy Economics Group of Arthur D. Little, Inc. . . . **Michael S. Cucchissi** is a law clerk for Federal Judge Samuel P. King in Hawaii. . . . **Derry Kabcenell** is working for Xerox in El Segundo, Calif., and is "gradually getting used to the Los Angeles experience." . . . **Michael E. Wilens** is "still surviving in Ann Arbor; hopefully will complete the Ph.D. within the year and then, who knows?"

Two lengthy notes from classmates **Daniel B. Jones** and **Paula Lieberman**. Thanks for writing! After leaving the Institute, Daniel worked for the Navy for about two years. Most of his time was spent at the Naval Civil Engineering Laboratory in Port Hueneme, Calif., where he worked on the development of underwater cable connectors. In June, 1977, he retired and went to Europe for three months. From Greece he went to Israel where he lived on a kibbutz and worked in their cotton fields for three months. Then he went down to Kenya for seven weeks, three of which he spent loafing on the beaches. According to Daniel, Kenya is very inexpensive, "coconuts are free and pineapples are 40 cents each." A more balanced bill of fare was never served at Lobdell. From Kenya, he went back to Europe for another three months and then came back to the U.S. where he "suffered a severe attack of culture shock." He's now a student and teaching assistant in the mechanical engineering department at the University of California at Berkeley. "Berkeley is a nice place to live and T.A.ing is enjoyable, but getting into the swing of studying, doing problem sets and taking exams has been a real ordeal."

Paula Lieberman, after "getting out" of the Institute, spent a month or two working in a factory, traveled, and then spent six weeks of Air Force active duty at Keesler A.F.B. in Mississippi, "a very hot and sticky place in August." She then spent two years in Colorado Springs as a Space Defense Center orbital analyst inside Cheyenne Mountain: "It turned out that I worked on cataloging the 1,000th successfully launched Russian payload Cosmos 954 which I had no part in keeping track of — by that time I was working in a different section of the S.D.C." Eventually she got an assignment in Thule, Greenland, the land north of the Arctic Circle where she is now. She wasn't too fond of Colorado Springs (where, by the way, she got her private pilot's certificate) because there was "too much flat, tireless plain among other things such as culture shock (all those married types my age with two or three or four kids)". In her nearly nine months (as of December) in Thule, she has walked through frozen tunnels, seen the midnight sun and the noonday dark, and not gotten bitten by any rabid Arctic foxes, "also known as 'Archies'." She has three more months to go up there. Good luck to you, Paula! . . .

Thinking of Paula reminds me that I bumped into her freshman year roommate **Candy Kalish** in the hall the other day (they were my neighbors in McCormick). She's working toward her doctorate in linguistics at Harvard. . . . I heard from *my* freshman year roommate, **Ilene Gordon** over the holidays. She's living in London where she has bought a flat, still working for the Boston Consulting Group. Ilene, if you read this, the reason I haven't written is because I lost your return address. . . . Had an extended lunch with **Lenny Deroma** in New York over the holidays. He was playing hookey (said he was sick, but he didn't seem any sicker than usual) for the day from his job with Citibank. Too bad, I had hoped to have seen him in all his conservative banker's glory. Next time.

Keep those cards and letters coming! — **Jennifer Gordon**, Secretary, 22 Centre St., Number 9, Cambridge, Mass. 02139

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I am sorry to report the death of James A. Cole. He died in an auto accident while vacationing in

David H. Lockwood, '75, North American tiddlywinks champion, is a Pan American Airways transportation engineer when he is not "winking." (Photo: Harry Leder, U.P.I.)

Why Tiddlywinks? Because It Was There

When David Lockwood entered M.I.T. he was asked what activities he was interested in, so he checked baseball, skydiving, and finally tiddlywinks simply because it was on the questionnaire list. Now he is the North American tiddlywinks champion.

After one harrowing experience with skydiving resulting in a set of broken eyeglasses and a lingering fear of heights, Mr. Lockwood visited an M.I.T. Tiddlywinks Club meeting. He was impressed with the way the game was taken seriously.

The object of the game appears simple enough: using a squidger (shooter), one flips his own winks into the cup (potting) while keeping the opponent's out. However, there are various strategical moves, such as piddling (freeing winks from under the opponent's winks) and Bristoling (using a vertical squidger to have two winks jump another at once).

Unlike chess, which has limited predictable moves, winks is a game of chance as well as skill, says Mr. Lockwood. "In tiddlywinks one has to figure the probabilities of success and weigh them against the consequences of failure." It is this element of strategy which separates tournament play from child's play, he points out. — *S.K.*

Cheers vs. Cheerleaders

E to the x, du, dx
E to the x dx
Cosine! Secant! Tangent! Sine!
Three point one four one five nine!
Square root, integral, udv,
Slipstick, sliderule, M.I.T.!

Does that familiar cheer qualify Glenn Brownstein, '77, to be an expert on cheerleading?

Well, perhaps it does. For Mr. Brownstein is now a sports writer for *Metro-East Journal*, East St. Louis, following high school and college sports ("and an occasional shot at Cardinals baseball") for 40,000 subscribers to this suburban daily.

Mr. Brownstein's lament in a recent column on cheers and cheerleaders was that the two are growing to be worlds apart. The Cardinals' "Big Red Line" cheerleading squad is much more devoted to public relations and promotion than to leading cheers — indeed, who ever heard a cheer at a professional ball game? And the Dallas Cowboys' squad . . . well, that's another story.

Even in St. Louis-area high schools, cheerleading is becoming professionalized — "something for the girls to accomplish," the coach of the national champion Belleville (Ill.) cheerleading team told Mr. Brownstein. "You know, everybody wants to win — it's kind of the American dream."

But if you have a cheer like M.I.T.'s, said Mr. Brownstein, "who needs cheerleaders anyway?"

New York State. Jim got his M.S. degree from Course XX with us. (His undergraduate days were at Cornell.) Our sympathies go out to his parents and siblings.

From the mails we have diverse news: **John Galkowski** reports that he married Peggy Wimpfheimer, '74, in September, 1976. In May of 1976 he joined IBM Federal Systems Division in Owego, N.Y., where he is a software engineer doing applied research and development in real time communications and parallel processing systems. He reports that they "are buying a new house and are scurrying around doing all the things new homeowners do. We miss the Cambridge area badly, especially the cool, green hiking trails of nearby New Hampshire. Peggy is a systems engineer at F.S.D. Owego designing emitter location systems involving lots of digital signal processing."

Cliff Grimes writes that he "expects to graduate from Brown in February with an M.S. in engineering and soon thereafter, at the end of the month, my wife and I are expecting our first child." . . . **Harvy Simkovits** sends word that he is working as the instrument department supervisor for Proctor and Gamble of Canada in Hamilton, Ontario: "am learning a lot and enjoying my job." . . . **George Todd** is working as a field engineer for Schlumberger Offshore Drilling Service out of their Houston office. . . . **Robert "Bo" (Olson) Fried** is now in his third year of medical school at N.Y.U. in Albany, "and still kicking."

Dominick Bruno is now back at the 'Tute as a graduate student in aero and astro, and is working as a research assistant at Draper Labs. . . . **Olimpio DeMarco** sends word that he was "employed for two-and-a-half years at R.C.A. in Burlington, Mass., as a mechanical engineer in the product design department, pursuing a master's degree in engineering management, associate instructor (in-house R.C.A. course) teaching 'mechanical modeling' and am living in Burlington. I am active in tennis, bowling, and softball leagues." . . . **Mitchel Kling** was originally class of '77. However, he joined us by graduating in September, 1976. He attended Rutgers Medical School for two years, and now, after a transfer, is in his third year at Harvard Medical School. He reports that "it's great to be back."

Steve Picus saw **Sheldon Katz** during Christmas vacation on the train from Princeton to Boston. Sheldon is doing fine in the math department at Princeton, as is **Dave Gabai**, who is also in his third year. Steve told me that **Pat Diamond** is getting out of the 'Tute with a landmark thesis in plasma physics and will be going to the Institute for Advanced Studies, located in Princeton, N.J. Steve is doing fine in his third year at M.I.T.'s math department.

While in New York for the wedding of **Dan Dershowitz** and Debby Gross, '77, on December 25, your secretary had the pleasure of staying with **Mike Steckler**. Mike is still at Lamont School of Oceanography at Columbia and had just recently published his first paper. Your secretary was impressed by Mike's apartment, complete with doorman! Mike has been heavily involved with origami (the Japanese art of paper folding) since his M.I.T. days and had some of his works incorporated into the origami-festooned Christmas trees at the Museum of Natural History and at the Japan Airline exhibit (Just beautiful!).

Prior to the wedding, Mike and I dropped by the New York Athletic Club, where **Erland Van Lidthe de Jeude** was supposed to be wrestling. Erland's opponents defaulted, leaving him with the task of scorekeeper. We caught Erland attired in a three-piece pinstripe, which made for a most imposing banking image, as he had started his new job with Citibank!

As for Dan and Debby's wedding, it was excellent. The ceremonies were held in a beautiful temple in Sheepshead Bay, Brooklyn. Among the M.I.T. people in attendance were: Michele ('79) and **Gary Buchwald**, Esther ('79) and **Jeffe Jaffe**, Laura Shultz, Karen Penso, Julia Malake, Jeremy Nussbaum, Arlene (M.S. '77) and Stuart Scharff, David (Ph.D. '78) and Tobie Ellis, Michael Stiefel and Bill Dershowitz, '78, the best man. The Dershowitzs honeymooned in the Netherlands and London, and were not overly plagued by exchange rate fluctuations, as they had prudently converted their money to British pounds before they left.

As for your secretary, he has been having an interesting time watching precious metals (gold, silver, platinum, and palladium) bounce around in price, without getting singed. So we can have more news, *write*. — **Arthur J. Carp**, Secretary, Endymion Commodities, Inc., 131 State St., Suite 616, Boston, Mass. 02109

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As I type this letter I am listening to a tape-letter from a classmate of ours who prefers to remain nameless. Unfortunately, *most* of my informants prefer to remain nameless. As a result my gossip smear sheet will be short this issue.

Among the brave is **Mitch Hollander**, now a chemistry grad student at Purdue. Somehow, Mitch manages to squeeze enough time out of a week to be a teaching assistant, take a few classes and put in some time doing lighting work at a theater. He does seem to enjoy living in Indiana.

By the time this is printed **Doug King** and **Sharon Pastoriza** will be celebrating their honeymoon out in central California. Sharon wirtes that she is working in Dublin, Calif., for HEXCEL — the same people who make your skis — conducting research and development for their medical products division. She and Doug remain dancing enthusiasts but after a short sampling of the discos they have returned to dance halls. Sharon reports that she's run into several of our classmates: **Brian Maiorella** is at the University of California, Berkeley, in chemical engineering. Brian was largely responsible for the giant block of ice contest our last I.A.P. . . . **Brian Nield** is at Stanford as a graduate student in aeronautics. He recently got a license for soaring — sometimes called gliding. . . . **Robby McGrath**, who is in electrical engineering graduate school at Berkeley, is also the maintenance man at Sharon's apartment building. . . . **Jung Choi**, another former leader of M.I.T.'s Ballroom Dance Club, is yet another 'Tute person out in California. He is a biology graduate student at the University of California, San Diego; Sharon reports that Jung misses the "community" at M.I.T. (I have difficulty understanding that; the entire M.I.T. community seems to be right there in Southern California.)

Pete Shaw is also in San Diego, as a graduate student at the Scripps Institute studying physical oceanography. He writes that Southern California is okay, except for a couple of natural disasters — he even sent me the Richter Scale readings. . . . Also in San Diego is **Gary Cote**, another biology graduate student at the University of California along with Jung and **Lisa Albright**.

James J. Heeger writes that he is a Credit Specialist at Chase Manhattan Bank in New York. Jim will be going to Stanford Business School starting September, 1980. . . . **Alfred W. Chock** is now a graduate student in M.I.T.'s Civil Engineering Department, working on a research assistantship from the Aeronautics and Astronautics Department. Not too shabby for an architecture undergrad! Al remains living in his Commonwealth Avenue apartment with his pet plastic rat Lucius and our classmate, **Jim Schuster**. . . . **Jim Bidigare** recently took a job in the Big Apple as Regional Coordinator for the Mid-Atlantic States of the M.I.T. Alumni Association. If any of you are in New York, be sure to get in touch with him so he may show you what the Alumni Association can do for you.

As a final note, I received word from **Michael Cahen**; and I quote: "I am presently chasing papers at Hofstra Law School and loving it!" As a fellow law student, I can sympathize with the troubles our classmate is having; perhaps the pressures have finally gotten to him. Mike, have you tried meditation? If I don't start receiving more news the next column will be entirely in legal jargon. Better start writing. — **David S. Browne**, Secretary, 551 South State St., Ann Arbor, Mich. 48109

Courses

I
Civil Engineering

A new member of the Florida Supreme Court is **Horace Schow II,** S.M. '61. He was sworn in on May 15, last year. . . . **Walt Hylander,** S.M. '50, writes: "In November, 1978, I completed two years as training and education manager with Bechtel at Jubail in Saudi Arabia; now appointed training supervisor with Mississippi Power and Light Co." . . . **Roger Arndt,** Ph.D. '62, is director of the University of Minnesota's Saint Anthony Falls Hydraulics Laboratory, and in July last year he was appointed the first Theodore Ranz Distinguished Lecturer at S.U.N.Y.-Buffalo.

Donald C. Taylor, S.M. '56, received a Ph.D. in civil engineering from Colorado State last summer and went to work immediately to set up his own engineering practice, plus a sister company for industry research and technology. . . . From **Stanley White,** S.M. '76, we hear: "I have changed jobs and will be working for Dravo Van Houten in New York. They are marine consulting engineers and I will be going in as a project manager–engineer working with coastal and offshore problems."

II
Mechanical Engineering

Charles K. Leeper, Sc.D. '48, former engineering manager for the service propulsion engine used in the Apollo space program, has been elected vice president for corporate technology for Combustion Engineering. . . . **Richard A. Mathias,** S.M. '71, is this year's recipient of the annual Engineering Citation Award from S.M.E. to be presented in Detroit on April 30. Mr. Mathias lives in Seattle, where he is vice president and engineering director for the MacoTech Corp. . . . **Daniel M. Hancock,** S.M. '73, writes that he is "system design and development coordinator for microcomputer-controlled hydromechanical transmission, to be used in track-laying vehicles."

David Plummer, S.M. '74, recently joined Research and Development Associates as a member of the technical staff supporting Air Force Weapons Lab in their high energy laser programs. . . . Once again the Certificate of Recognition from N.A.S.A. goes to **Ashok B. Boghani,** Sc.D. '74, for his work on air cushion landing systems. . . . **Michael A. Feldstein,** S.M. '66, completed the Program for Management Development at Harvard Business School in December and works in engineering management at Data General.

Robert H. Cannon, Sc.D. '50, is chairman of the Division of Engineering and Applied Science at Caltech. . . . **Leonard E. Smollen,** M.E. '62, is the co-author of two new books on business management and finance: *New Venture Creation,* published by Richard D. Irwin and *Source for Borrowing Capital,* published by Capital Publishing Corp. . . . **Mario Rathle,** S.M. '59, has moved to France to join the Michelin Tire Corp. where he is working on various international projects.

IV
Architecture

President of the Ontario M.I.T. Club is **D. F. Taylor,** C.P. '50. He writes that he hopes to inspire alumni there to contribute greatly to the alumni fund. While not engaged in fundraising, Mr. Taylor is working on a plan for Niagara Escarpment on a stretch of 450 miles, from Tobermory to the Niagara River. . . . **Ray W. Geiger,** M.Arch. '65, is principal and vice president of Leonard Parker Associates in Minnesota. . . . **Barbara Putnam,** M.Arch. '77, writes: "I am presently completing the construction of my own house in Harrisville, while continuing to do design, consulting and teaching part-time with Total Environment Action."

From **Robert L. Ziegelman,** M.Arch. '59, the following note: "Barged a 200-bed hospital from Houston to Guatemala, using a patented modular system developed shortly after leaving M.I.T. Construction took one year instead of five years required for on-site construction." . . . **David D. Wallace,** B.Arch. '52, reports that he is a principal in Wallace, Floyd, Ellenzweig, Moore architects and planners. Their work includes new and remodeled subway stations for the M.B.T.A., airport planning, and community development.

VI
Electrical Engineering and Computer Science

Jacob Ziv, Sc.D. '62, is appointed vice president for academic affairs of Technion–Israel Institute of Technology. . . . **Walter (Pete) Henry,** S.M. '52, is now chief engineer at Arens Applied Electromagnetics in Gaithersburg, Md. . . . **William T. Lincoln,** S.M. '53, is working on a major advancement for broadcasting, as director of engineering for the satellite interconnect project. This will provide four 15 KHz. program channels to all public radio stations, expandable to 12 channels in the future. . . . **Larry Morris,** S.M. '59, has joined Lincoln Labs as a staff member. He also writes that his son Evan is in the class of '82.

Jack McKelvie, S.M. '49, recently moved to Ann Arbor to become director of research and development at Manufacturing Data Systems. . . . **Lynden Kibler,** S.M. '56, has transferred from Bell Telephone to A.T.&T. General Department. . . . **Peter Jessel,** Ph.D. '72, reports his promotion to manager of systems engineering and product planning for the Telecommunications Group at Digital. . . . A new book on applications of mag-

The State's "Mr. Transit" Brings His Research Priorities to M.I.T.

What should be the nation's number-one priority?

Transportation, says Frederick P. Salvucci, '61, who's just joined the M.I.T. Center for Transportation Studies after four years as secretary of transportation and construction in the Massachusetts administration of Governor Michael Dukakis.

"Given the energy situation and inflation, transit ought to be on the top of the national priority list," Mr. Salvucci told Fred Pillsbury of the *Boston Globe* as he left his State House job.

That's why he came to M.I.T. — to work on that priority by taking a key role in research on contingency plans for transportation energy — a major project at the Center. He's now special assistant to the director of the Center for Transportation Studies and senior lecturer in the Department of Civil Engineering.

Reviewing his four years of state service, Mr. Salvucci told Mr. Pillsbury that his most important accomplishment was successful support of major extensions and improvements for Boston's subway system.

Mr. Salvucci's biggest disappointment was failing to achieve public ownership of railroad rights of way in Massachusetts. His view of the future is that "rights of way should be publicly owned and operated like highways"; then the railroads could put their own limited capital resources to work on improving their services.

Mr. Salvucci's "transportation philosophy": "I think that transportation is not an end in itself but a means to move towards the kind of society we want. What I've tried to develop is a set of transportation investments which strengthen and enhance our neighborhoods and our lifestyles, provide jobs and economic activity, and at the same time respect the environment.

"People call Boston a livable and walkable city and Massachusetts a livable state. I think good transportation can make them better."

netism is scheduled to appear some time this year. The author is **J. Kenneth Watson,** S.M. '55, who writes, "This book seeks to help bridge the gap between theory and design for static magnetic devices at a level that is intended to be useful not only to advanced undergraduates but also to practicing engineers."

James L. Flanagan, Sc.D. '50, is head of the Acoustics Research Department at Bell Laboratories in Murray Hill, N.J., and he is currently serving as president of the Acoustical Society of America. . . . **Kenneth Hatch,** Ph.D. '72, is science consultant with Picker Corp. . . . **Harry Swain,** S.M. '60, has been with Chloride Power Inc. as vice president of engineering for almost a year now. . . . **Jeffrey A. Kaplan,** S.M. '71, writes that he is now "lead project programmer in the Electric Power Control Systems Division of Leeds and Northrup Co. My wife, Patrice, is expecting our first child at the end of January, 1979."

VI–A

Cooperative Program in Electrical Engineering and Computer Science

Director **John Tucker** happily reports that since December 4, 1978, he has been back at M.I.T. working on a full-time basis following his heart attack of September 23, 1978. The many, many communications received from VI–A alumni were heartwarming and literally overwhelming. They were much appreciated.

The I.E.E.E. has elevated two VI–A people to their highest grade of membership — that of Fellow: Professor **David H. Staelin,** '60, M.I.T.'s VI–A Faculty Advisor to the G.E. Co.'s Electronic Systems Division in Pittsfield, Mass., whose citation reads: "For advances in radio astronomy and the development of microwave radiometric probes"; and **Robert A. Pucel,** '50 (VI–A with G.E. Co.) of Raytheon Co.'s Research Division in Waltham, Mass., whose citation reads: "For contributions to the modeling of microwave solid-state devices and leadership in their application." Congratulations to them both on this high honor!

The Electrical Engineering and Computer Science Department has appointed three new VI–A Faculty Advisors:

☐ Professor **David Adler** will serve not only the Fairchild Camera and Instrument Corp.'s Research and Development Labs in Palo Alto, Calif. — which is returning to the VI–A Program after a two-year absence — but will also be advisor to Motorola's Semiconductor Group in Phoenix, Ariz. The Phoenix facility plans to take VI–A students for the first time this year.

☐ Professor **J. C. R. Licklider** will become the first Advisor to General Electric's Special Purpose Computer Center in Bridgeport, Conn., which joins the VI–A Program this year.

☐ Professor **Joel Moses,** Ph.D. '67, newly appointed associate department head for Computer Science and Engineering, will take over as VI–A Faculty Advisor to the Charles S. Draper Laboratory in Cambridge, Mass.

Director Tucker has attended several dinner parties of alumni in the area. One was hosted by Dr. and Mrs. **Dale C. Flanders,** '73 (VI–A with Bell Labs), of Lexington, Mass. — Dale is currently with M.I.T.'s Lincoln Laboratory; another was with Dr. and Mrs. **David E. Meharry,** '71 (VI–A with General Radio Co.), of Lexington, Mass. — Dave received his doctorate from the Helsinki University of Technology and is now back in this country with Microwave Associates in Burlington, Mass. Also at the Meharry social was Mr. and Mrs. **Andrew E. Moysenko,** '72 (VI–A with Raytheon Co.) — Andy is also with Microwave Associates.

While in downtown Boston, in December, Mr. Tucker had a chance meeting with **Vernon E. Altman,** '71 (VI–A with Honeywell's E.D.P. Division, Waltham, Mass.). Vernon is with Bain and Co., consultants, has spent some time for them in Germany, and is now spending most of his time at their Los Altos, Calif., office and in Japan. . . . A Christmas note from **John D. Chisholm,** '75 (VI–A with G.E. Co., Pittsfield, Mass.) tells us he is now with Hewlett-Packard's General Systems Division in Santa Clara, Calif. John got his M.B.A. from Harvard following M.I.T. . . . **James L. Fenton,** '77 (VI–A with Digital Equipment Corp.) has graduated and taken a position in California with the Watkins-Johnson Co. . . . **Edward C. Giaimo,** '74 (VI–A with Hewlett-Packard/Data Systems) transferred in December to Hewlett-Packard Co.'s Colorado Springs Division. While east over the Christmas holidays he joined Mr. Tucker and **Bradford E. Hampson,** '75 (VI–A with Hewlett-Packard's Medical Group in Waltham, Mass.) for dinner. Brad is with Prime Computer in Newton, Mass.

Daniel G. Jablonski, '76 (VI–A with Naval Surface Weapons Center, Md.) called from Washington, D.C., at Christmastime to tell us that he is working in the low-temperature physics section of the Cavendish Laboratory in Cambridge, England. He hopes to receive his Ph.D. from Cambridge in another two years. . . . **Paul M. Menig,** '76 (VI–A with G.E. Co.) has transferred within the G.E. Co. from Corporation Research and Development in Schenectady, N.Y., to their Medical Products Group in Milwaukee, Wis. . . . **Stephen P. Tobin,** '76 (VI–A with Honeywell) has completed his degree requirements and has accepted a position with the Honeywell Electro-Optics Center in Lexington, Mass., his VI–A employing company.

Back on September 6, 1978, Dr. **Eugene W. Boehne,** '28, former Director of the VI–A Program, had lunch at M.I.T. with John Tucker. He mentioned, at that time, that **Vincent L. McKusick,** '47 (VI–A with G.E. Co.) and also a Harvard Law School graduate, had been appointed to a Chief Judgeship in the State of Maine. — **John A. Tucker,** Director, VI–A Program, Room 38–473, M.I.T., Cambridge, Mass. 02139

VII

Biology

Marian F. Koshland will spend 1979 as visiting professor in the department, working in the laboratory of Professor David Baltimore cloning immunoglobulin genes and gene fragments; she is on leave from the faculty of the University of California, Berkeley. Dr. Koshland studied at Vassar (B.A. 1942) and the University of Chicago (M.S. 1943, Ph.D. 1949).

Flora N. Katz, Ph.D. '78, left for Asia last fall for a ten-month professional internship as a Luce Scholar. She is part of a group of 15 young Americans, selected from over 120 candidates. Ms. Katz' assignment brought her to the Lembaga Biologi Nasional in Bogor, Indonesia. . . . **John Hunt,** S.M. '70, is going to complete his fourth year as a high school science teacher in Monona, Wis., this spring and then return to research as a post-doc in chemical carcinogenesis at the Universtity of Wisconsin in Madison. . . . **Emanuel Goldman,** Ph.D. '72, sends us this account of his activities: "Assistant research microbiologist at the Unviersity of California, Irvine; Lierre Senior Fellow of the California Division of the American Cancer Society; continue to publish film criticism regularly, have written one-and-a-half novels, and completed a non-fiction book (which I'm trying to get published); and occasionally play piano in cocktail lounges."

VIII

Physics

Five new appointments in the Department of Physics:

☐ **Susan G. Kleinmann** has been promoted from assistant to associate professor; she studied at Trinity College and Rice University and joined the M.I.T. faculty following a six-month appointment as research associate in 1972.

☐ **Donald Q. Lamb,** associate professor of physics at the University of Illinois (Urbana), is visiting associate professor this year. He is continuing theoretical studies of cosmic x-ray sources and teaching related material.

☐ **David Lazarus,** a well known experimental physicist in the field of the solid state, is visiting professor for the current year; he's on leave from his position as professor of physics at the University of Illinois. Professor Lazarus's work is on fundamental properties of metals, including conductivity and diffusion.

☐ **Peter S. Pershan,** who was until this year director of the Materials Research Laboratory at Harvard, is at M.I.T. to work on liquid crystal phase-transition organic materials; he's on leave from his post as Gordon McKay Professor of Applied Physics.

☐ **Georges Ripka,** who has been director of summer teaching programs on nuclear physics in France and italy, is visiting professor of physics, working on the nuclear many-body problem.

Glenn A. Burdick, Ph.D. '61, is full professor at the University of South Florida and president of the International Society of Hybrid Microelectronics. . . . **W. Murray Bullis,** Ph.D. '56, was recently named chief of the Electron Devices Division of the National Bureau of Standards. . . . **Louise Wholey,** S.M. '68, writes that she is on maternity leave from Digital Equipment Corp. On November 13 last year, her daughter Mary Louise was born. . . . From **David L. Swift,** S.M. '59, the following note: "In October I was promoted to professor of Environmental Health Sciences in the Johns Hopkins School of Hygiene and Public Health. I have been teaching and doing research in environmental physiology and industrial hygiene since 1966, with a primary interest in airborne particles."

IX

Psychology

Dr. **Norman Geschwind,** James Jackson Putnam Professor of Neurology at Harvard Medical School who is director of the Neurological Unit at Beth Israel Hospital, is visiting professor (part time) in the Department of Psychology and the Harvard-M.I.T. Division of Health Sciences and Technology; he's continuing research on neurological foundations of behavior, especially language and emotional problems resulting from brain disorders.

Harold H. Kelley, Ph.D. '48, and **John W. Thibaut,** Ph.D. '49, were colleagues at M.I.T. studying social psychology when that field was included in the Department of Economics. Now they are co-authors of *Interpersonal Relations: A Theory of Interdependence* (New York: John Wiley and Sons, Inc., 1978, $18.95). The book, viewed by its authors as a companion to their 1959 title, *The Social Psychology of Groups* (New York: Wiley, $12.50), is said by its publishers to be "the most thorough analysis of interdependence available . . . an in-depth, systematic examination of the causes, consequences, and possible variations of interdependence in two- and three-person groups. . . ." Dr. Kelley is professor of psychology at the University of California, Los Angeles, and Dr. Thibaut is Alumni Distinguished Professor of Psychology at the University of North Carolina, Chapel Hill.

X

Chemical Engineering

Stephen C. Dodd, S.M. '76, writes, "I am presently the company chemical engineer for the Daven Co. in Jersey City. I have been with them since April, 1978. My major areas at work are energy management, process design and research." . . . **Marc Machbitz,** S.M. '78, reports that he made sure to do a lot of traveling before getting established in the working world. After graduation he took off to Israel and France and after that spent five weeks driving 9,000 miles around the United States. His final stop was San Francisco — where he is now a design engineer with Standard Oil. . . . Also at Standard Oil is **Joseph E. Leitgeb,** S.M. '57; he is responsible for coordinating the national professional recruiting program as well as administering the scholarship and fellowship aid to education programs. . . . **Thomas H. Goodgame,** Sc.D. '53, director of Environmental Control for the Whirlpool Corp. has been honored by the American Institute of Chemical Engineers; he was the recipient of the 1978 Environmental Award presented in Miami Beach in November. The award is given each year to recognize and encourage individual and outstanding contributions toward the preservation and/or [illegible]vement of man's natural environment.

[illegible]ce Kunstenaar, S.M. '50, writes that he [illegible]cientific Design in New York City in mid-[illegible]s director of Latin American sales. . . . **Robert B. Flanders,** S.M. '58, says that in 1977 he got an offer he couldn't refuse, so he retired from Stone and Webster and is now senior applications engineer for N.R.C., where he makes a fabricable metal from tantalum ore and then finds applications for it in the chemical industry. . . . **Robert L. Huffman,** S.M. '42, has retired from Du Pont's Plastic Products and Resins Department. . . . **Robert E. Latimer,** '46, writes about his travels: "My wife Doris and I toured northern Manitoba and Saskatchewan by auto last August and then went by train to Churchill on Hudson Bay — there is no road there."

Albert L. Schulerud, S.M. '34, has been retired for four years now, and he writes that he is busy with part-time consulting on soap processing plus a lot of other activities: glee club and oratorio singing, gardening, golf, and bowling. . . . **John D. Ireland,** S.M. '47, has been elected president of Pedco Thermal, a company specializing in energy conservation by using infrared thermography to detect heat leakages. . . . A note from **Harvey L. Fein,** Sc.D. '61, reads: "Doing process analysis work in the area of synthetic fuels from coal. Second child, a daughter named Alison Rachel, born on February 27, 1978." . . . Another daughter makes the news: **Ed Field,** S.M. '50, reports proudly, "Had a special treat last June, watching daughter Leslie get the same S.M. degree in the same place [Rockwell Cage] in which her dad got his 28 years earlier, almost to the day. Have been living in Lexington and working at Arthur D. Little for almost 17 years now, still find it exciting." . . . From **David S. Hacker,** S.M. '50: "Daughter Karen is a first year med student at Northwestern University, daughter Julie to be graduated from Wesleyan University in the spring. My own research continues in coal liquefaction thermodynamics and photocatalysis at the University of Illinois.

XI

Urban Studies and Planning

Richard S. Howe, S.M. '61, is now professor and director of the Division of Environmental Studies at the Unviersity of Texas in San Antonio, and also director in the San Antonio Area Office of Texas Energy Extension Service. . . . **Robert Bluhm,** M.C.P. '78, is an architect and planner with M.B.T. Associates in San Francisco. . . . The Chairman of the department of Urban Planning at the University of Washington in Seattle is **Alan Rabinowitz,** Ph.D. '69. . . . **James E. Wallace,** Ph.D. '72, has become project director for H.U.D.-sponsored national evaluation of the Low Income Housing Assistance Program.

Hans Bleiker, Ph.D. '72, writes, "My wife and I have formed I.P.P., the Institute for Participatory Planning, and are engaged in conducting in-house training programs in governmental agencies throughout the U.S. on the subject of how to manage projects that are controversial." . . . **Abbott Stillman,** M.C.P. '73, reports that he is operating his own real estate development company, the Stillman Group, and is building a 400,000-square-foot office building in Washington, D.C. After that he has plans to develop properties in New York, Boston, Chicago, and Florida. . . . **Suzann R. Thomas Buckle,** Ph.D. '74, has been promoted to associate professor in the department.

Wanted: A Community for Urban Studies Where People Can "Center Themselves"

Six objectives for his four-year tenure — just beginning — as Head of the Department of Urban Studies and Planning, says **Lawrence E. Susskind,** Ph.D. '73:

☐ Enhance "the quality of life" by making the Department a place "that's more fun to work in," where there is more social interaction, where people can "really center themselves."

☐ Enhance "the level of intellectual exchange" by improving the settings and increasing the opportunities for interaction between and among students and faculty.

☐ Increase the incentives for students and faculty to devote their full energy to the Department and its activities.

☐ Increase the coupling between the Department and the rest of M.I.T. "We haven't been aggressive enough about injecting ourselves into what's going on at the Institute," says Professor Susskind.

☐ Focus more sharply on the areas of specialization within the curriculum, to be sure that each one is "something that's worth doing."

☐ Extend recruitment efforts to be sure of a pool of students in the future "as large and as qualified as our current pool," and a similar pool of potential faculty members on which to draw when vacancies arise.

One of the plans along the way to achieving these goals, Professor Susskind told Jeff Cruikshank, newly-appointed Editor for Departmental publications, is to give students more opportunities to help manage the Department. Professor Susskind has created 12 new instructorships for advanced students ("Forcing out our most advanced students because they are advanced is crazy!") and will also appoint a series of part-time administrative assistants.

Learning How to Be a Chemical Engineer: The Students' Perspective on the Practice School

"You look at the real task in life; you begin to link science with human needs," says Richard Caron, '78, of his experience at M.I.T.'s Chemical Engineering Practice School at the plastics and silicone production facilities of General Electric at Albany, N.Y., and with the Nuclear Division of Union Carbide Corp. at Oak Ridge in Tennessee.

"A formal education is only a starting point. In the Practice School you learn how to translate scientific knowledge into something practical. You must know about current technology, and you must be creative."

The Practice School structure: one-month projects; two projects at each station (four projects total). "There is a lot of pressure to obtain the data and determine what the trends are, " says Mr. Caron.

"You work from the minute you arrive," explains Kevin Fallon, '78. "You arrive on a Tuesday; Thursday you have to finish an investigative memorandum on what you'll do about the problem you're assigned to, and by Friday a formal proposal is due."

Students work 60 to 80 hours a week. Mr. Caron thinks he did as much in four weeks as a staff engineer does in twice that time. "The environment is so intense, there is no chance for your mind to leave what you're working on. Pressure is at a maximum."

The assignments are not random — the Director is informed in advance of each student's interests. Nor are the problems academic; they're very real. "The company wants an answer, and if we weren't doing it professional engineers would be," says Mr. Fallon. This is one of the real motivations for Practice School students, they say: textbook examples are abstract; their use is not obvious. At Practice School you know the results you obtain are immediately used in a real-life situation. "And you get a personal evaluation of your work by people who want to use your recommendations," says Mr. Fallon.

"You also really appreciate courses when you come back to Cambridge. You think, 'I wish I knew that back when I was working on that problem.' So you remember what is learned in the course with an eye to its practical application."

One facet is extremely important: "The program teaches you how to work in a group situation. At M.I.T. you are independent, totally responsible for what you do, and competitive. In the Practice School, three or four people are working together for the benefit of each other and the rest of the group. They must coordinate their activities. They must make a decision about what individual work each will do. If one person on one task loses sight of the group activity, he can create chaos and lost momentum for the group. It requires practice to coordinate a group so they work effectively together.

"The biggest problem I had to confront was that I like to work alone," Mr. Caron explained. "Then I trust my data. I know when it will get done.

Engineering is a cooperative endeavor — that's why the Chemical Engineering Practical School always assigns students to work in groups. On a weekly basis, a member of the group discusses the group's progress and future plans. Meetings such as these (top, opposite) are attended by all participating students, staff, host plant consultants, and often visiting faculty from Cambridge. The photo at far left shows Roberto J. Marrero-Aldea, S.M. '79 (left), and Mark F. Zimmer, S.M. '79, reviewing their experimental findings at Oak Ridge; at the top of this page (left to right), Pamela McElroy, S.M. '79, Francis V. Gay II, S.M. '79, and Charles B. Goltman, S.M. '79, confer at the O.R.N.L. Tandem Van de Graaff Accelerator.

When I work with others, communication is essential — to make sure everyone knows the project objectives. Without that it's possible to end up with three people working on the same thing."

Students learned that through proper coordination, the group could be extremely effective; frequent meetings and constant encouragement were important. "Everyone must be made to feel that what they are doing is essential to the project. It's amazing how much excitement you can generate if you approach the problem from a different point of view, or discuss the results of someone's data. Then their work *means* something, and they get a sense of accomplishment," explains Mr. Caron.

He says he is now more anxious to go from academia into the real world. "Certainly I must develop personality traits which you don't need at the Institute: aggressiveness and the ability to *sell* your ideas to people." — *Marjorie Lyon*

Chemical Engineering Practice School Prepares Students for the Real World

by Selim M. Senkan, Sc.D. '77, David M. Camp, S.M. '74, and J. Edward Vivian, Sc.D. '45

Chemical engineers' assignments are today more diverse and complex than ever before and result in even more unanticipated problems. We live in a highly complicated and controversy-laden world, and chemical engineers face considerable uncertainty with respect to energy, environment, health, food, and raw materials supply; these are diverse, complex, and multifaceted challenges in an environment complicated by changing energy costs, material shortages, environmental regulations, social awareness, and domestic and international politics.

To meet these challenges, a strong background in chemical engineering fundamentals clearly is not enough. Chemical engineers are expected to function as a team with other professionals, making a goal-oriented and timetable-conscious approach to identifying and solving current and future problems. They are expected to be creative, productive, and effective in applying their knowledge to the solution of these problems and to be alert to the needs of sophisticated industrial operations and the dynamic society in which they live. They are expected to have excellent oral and written communication skills to help influence action and motivate individuals and to disseminate the results of their findings.

Last, but not least, they are expected to respond to needs of their communities and to be proficient in human relations.

Under these conditions, the transition from formal college education to the position of a responsible, practicing engineer is both complex and important. It is a time when judgment, common sense, and the ability to make simplifying assumptions based on the fundamentals learned in college must first be attempted; actual problems are always more complex than those "ideal" ones considered at school. Chemical engineers are expected to apply basic principles to a large variety of practical problems, even to ones once thought to be outside their professional jurisdiction. In addition, many non-technical merits — such as skills in communication and human relations — become vital and visible in this transition period.

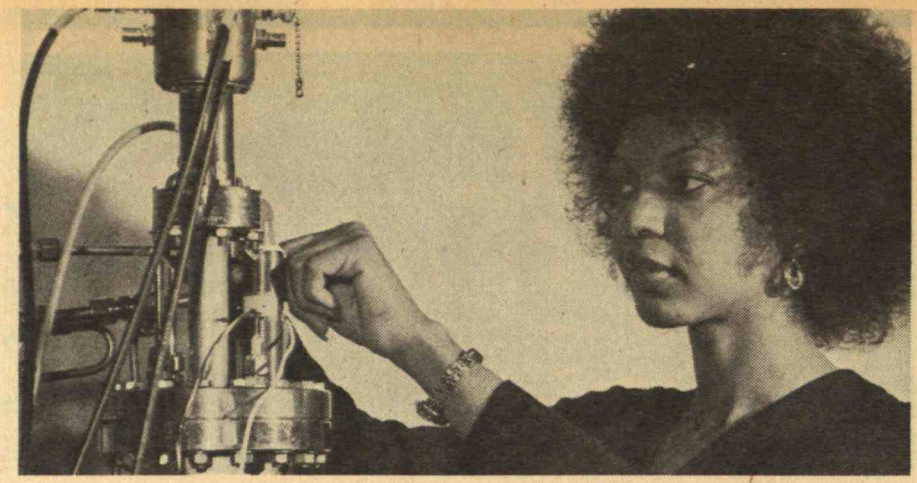
Though they could hardly have foreseen the complexities of today, some of these ideas clearly were in the minds of Arthur D. Little, '85, and William H. Walker when they established the School of Chemical Engineering Practice in 1916 to integrate classroom experience and practical work by providing students with an intensive, industrial- and research-oriented internship away from the campus, under the direct supervision of M.I.T. faculty members.

Like a Small Consulting Company

The Practice School operates much as a small consulting company, with student groups working intimately with host-plant staff in solving problems. The resident faculty ensures that assignments are of the most educational benefit to each student and that they result in a major contribution to the plant operation and/or to the understanding of a phenomenon of professional significance. This motivates the students to produce a great deal of good work in a short time, which is an important aspect of the Practice School operation; accordingly, the School has developed a reputation for producing high quality work on challenging and technical problems, and the final reports are sometimes presented at professional meetings and published in technical journals.

The level of the projects is such that successful completion of the one-semester program is accepted in lieu of a Master's thesis.

Practice School stations now operate at two locations: one at Oak Ridge National Laboratory, a dynamic research and development organization operated by the Nuclear Division of Union Carbide Corp. at Oak Ridge, Tenn., and the other at General Electric Co.'s modern plastics and silicone production facilities at Albany, N.Y. Re-



search and development at Oak Ridge National Laboratory is at the forefront of fusion energy, coal-conversion technology, and solar energy, to name a few. In the work at General Electric the emphasis is on technical and economic feasibility. The widely different operations of these plants provide for exposure to a large variety of technical activities in which engineering students are likely to find themselves engaged later in their careers. Indeed, perhaps nowhere else in graduate education today can a student in one semester gain such valuable practical exposure while also being expected to make effective contributions to such a broad spectrum of technical activities.

While the students are broadening their experience in technical aspects of the profession, they also learn practical lessons in communication and human relations, which are frequently decisive in the success of an engineering enterprise.

Each term, a select number of graduate students — presently the enrollment is limited to 24 — are admitted to the Practice School. Since the program is highly demanding, self-motivation, industriousness, and other such qualities are sought in addition to exceptional academic achievements. Each student spends a semester at the School, about eight weeks at each Station.

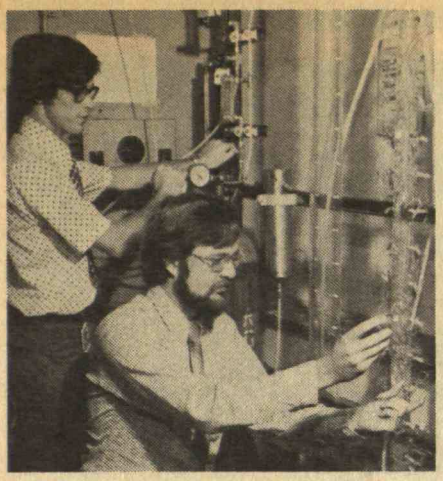
To develop goal-oriented, timetable-conscious, highly competent chemical engineers, the Practice School program stresses four major issues:

☐ *Development of an ability to apply engineering principles to a wide range of problems.* Students at the graduate level already have command of most of the fundamentals. However, the application of knowledge to the solution of today's problems is perhaps more difficult than ever before. Chemical engineers have contributed to a wide variety of disciplines which were once thought outside their purview. Practice School permits the students to face many kinds of unique industrial- and research-related problems in a variety of disciplines. The nature of the projects range from fusion-energy research, coal gasification and liquifaction, nuclear medicine to technical and economic feasibility analysis, design, operation and optimization of chemical processes. Every new problem — and new problems are assigned every four weeks — is presented as a challenge to the ability of the student. By stimulating students to meet these challenges, the Practice School encourages creativity and fosters the sense of achievement that accompanies the successful completion of any problem.

☐ *Development of the awareness that education must proceed with renewed vigor beyond classroom teaching.* Since chemical engineers are facing increasingly complex interdisciplinary problems, it is important to create an atmosphere in which individuals are motivated to become familiar with other disciplines, concepts, and ideas. The large variety of projects offered at Practice School brings about the realization of this need and provides students with relevant experience in handling new situations with caution and confidence.

☐ *Development of a proficiency in human relations.* To emphasize the cooperative nature of engineering tasks, Practice School projects are always assigned to student groups of two to four. This results in improved thinking and decision-making on behalf of the group members. On an engineering assignment, usually a small group decision is superior to that of an individual working alone. Small-group communication is conducive in changing group member's attitudes. Groups and designated group leaders change with each project, which gives each student a chance to become a group leader and an opportunity to work with others. Emphasis is placed on developing effective leadership and organization skills in handling complex assignments. Generation of cohesive and productive groups is accomplished by creating an atmosphere in which group identity and tradition survive, clear attainable goals are set, teamwork is stressed, and good work is recognized and rewarded.

☐ *Development of a proficiency in effective oral and written communication skills.* Results of a technical investigation have little utility unless they can be understood and used by others. A technical achievement can be outstanding, but unless the results are communicated effectively and persuasively, the value of the achievement is less



Students at the Chemical Engineering Practice School at Oak Ridge obtain "hands-on" experience. Pictured from left to right: Caridad M. Talbert, S.M. '79, adjusts the controls of an ionization chamber; William H. Sun, S.M. '79, works with a 3-phase fluidized bed reactor; John K. O'Neill, S.M. '74, and Jerry J. Toman, S.M. '74, conduct bubble-bed experiments.

likely to be appreciated. The Practice School provides the students with excellent experience in developing these skills.

Students get realistic experience in oral reporting during the projects. On a weekly basis, one member of the group gives an oral presentation outlining the progress and future plans of his group. These sessions are attended by all participating students, plant personnel, and Practice School staff. Participation in these periodic conferences provides the opportunity for students to rate each other and for the consultants and staff to rate the students. Each student is thus able to see himself as others do. On several occasions, students are also asked to present their work at symposia organized by professional societies such as the American Chemical Society, the American Institute of Chemical Engineers, and the American Nuclear Society.

Technical report writing is also an essential attribute of a competent engineer. Accordingly, a Practice School assignment is not considered complete until an acceptable written account of the work has been prepared. The program emphasizes the need for a precise and concise report of the effort, in which the approach and results are described and the strengths and weaknesses of the technical arguments are documented. These are important factors in establishing the credibility of the accomplishments — and, indeed, the credibility of the engineers who did the work.

Individual Learning and Group Interaction

Goals of the Practice School are attained in an unusual way. Each Practice School station is directed by an Assistant Professor of Chemical Engineering, assisted by an instructor. The student-to-faculty ratio is kept below six so that students may receive a high degree of individual instruction and evaluation and also so that their potential ability may be recognized and developed at the Practice School.

The M.I.T. staff surveys the problems suggested by the technical staff of the host company and assigns the most suitable ones to Practice School teams. The most important criteria used in problem selection are: first, problems must be of educational value to the student group; second, the solution can be expected to require in-depth application of a broad variety of technical skills, original thought, initiative, and judgment on the part of the student group; and third, solution of the problem must be of practical importance to the host company. Members of the technical staff of the host company who suggested the problem are asked to make themselves available to the students as consultants. Although the students bear prime responsibility for solving the problem, student groups are encouraged to draw for advice on the Practice School staff and plant staff and personnel, all of whom are considered part of a team whose job is to solve the problem. The group leader organizes the effort and keeps the project consultants and Practice School staff informed on group progress. Since the time available for solving the problems is short, the group finds itself under considerable pressure to accomplish its goals.

In sum, the Practice School is an intensive and guided program where the student develops qualities such as leadership, organization, planning, team-work, communication skills — economic and technical interaction which a competent engineer should possess, yet which are difficult to acquire in the classroom.

The opportunity to help solve some problems of concern to plant personnel or to contribute to the understanding of a phenomenon at the forefront of a research program motivates the student to accomplish a great deal of good work in a surprisingly short time. This attitude provides the key to Practice School operations and results in the production of widely recognized high-quality work.

Authors are in the M.I.T. Department of Chemical Engineering. S. M. Senkan is an Assistant Professor and Director of the School of Chemical Engineering Practice at Oak Ridge National Laboratory, Oak Ridge, Tenn. D. M. Camp is an Instructor and Director of the School of Chemical Engineering Practice at General Electric Company, Waterford, N.Y. J. E. Vivian is Professor and Executive Officer of the Department and Director of the School of Chemical Engineering Practice Program.

Computers are not management's be-all, end-all problem solvers. Some things they can do, some they can't; and some management functions are in a sort of never-never land in between. It is here where a new concept of computer-based decision support systems described by Professor Michael S. Scott Morton (right) of the Sloan School of Management comes to the fore. Professor Scott Morton is shown speaking to more than 300 executives from throughout the eastern U.S. attending a management information systems seminar arranged by the M.I.T. Alumni Center of New York in December.

Management Information: The Technology Is Ahead of Its Users

Everyone knows that the technology of computers is rushing rapidly ahead: what took a roomful of hardware a decade ago can now be done on a single semiconductor chip, and the computer that cost $50,000 today will soon be replaced by a $2,000 black box.

But this fact of vast technological change doesn't by itself assure change in the way the technology is used. The key issue in management information systems, for example, is not their larger size or lower cost; the question is whether the new systems and their users are fast enough on their feet to keep pace with changing demands and to ask the right questions.

An example from John J. Donovan, professor of management science in the Sloan School, speaking at a management seminar on information systems sponsored by the M.I.T. Alumni Center of New York late last year: the manager of a nearby Boston building asked Professor Donovan's computer how much energy could be saved by installing storm windows. The computer's answer was, not very much. But that wasn't really what the manager wanted to know, and Professor Donovan's computer was next asked to draw on a very different kind of databank: What's the most cost-effective way of saving energy in my building?

The size of the computer devoted to management information in today's environment doesn't matter very much, said Professor Donovan. What matters is how adaptable it is, how quickly it can turn from one database to another, how nimble it is at correcting the boss's mistakes.

The symposium keynoter, Edison D. de Castro, founder and President of Data General Corp., put the same idea in terms of what he called the "pluralistic nature of today's information systems" — in contrast to those of 20 years ago. The proper design for today's systems, he said, is ever-smaller computers with modular software packages in place of yesterday's massive, monolithic machines and systems with centralized staffs in distant data-processing shops.

Identifying What Makes the Difference

How to think about all the many ways a modern management information system may work for its users?

Professor John F. Rockart, Ph.D. '68, director of the Sloan School's Center for Information Systems Research, proposed that managers' information needs are of two kinds:

☐ "Scorekeeping" data which relates present achievements of the company to its previous achievements and its goals.

☐ Data on company performance on a few "critical success factors" — the things which ultimately will make the difference between success and failure. In the grocery business, for example, a manager's critical factors might in-

clude having the right mix of products in the store, having the right levels of inventory, having successful advertising and sales promotions, and having just the right pricing policy.

As conditions change, the executive's "critical success factors" should change.

This concept imposes two conditions on the information systems: it means that executives must go beyond relying on whatever information their computer can give; they must be prepared to ask for what they need. And it means that computing needs will change as information needs change — the idea of flexibility, which was Professor Donovan's point as the symposium opened.

From his side of the desk, John S. Reed, '61, executive vice president of Citicorp, sees it exactly the same way: "If you don't find your information systems useful," he told managers at the symposium, "stand up and have them changed. Well managed companies do not have bad information systems."

A Revolution in Technology, Not in Its Use

Perhaps 90 per cent of today's managers have "inquiry" systems, said Professor Rockart: they can have on demand whatever information about current activities the system can provide — more figures than the Chase Manhattan Bank, as the saying goes. But only 10 per cent have the kind of systems they really need: systems with forecasting ability, that are flexible enough to draw on different databases and compare, for example, apples and oranges.

The problem in a nutshell, concluded Michael D. Zisman, professor of management science: "We have a revolution in technology but not in its use — and where we need this revolution now is where the rubber hits the road." — *J.M.*

A Low Profile for International Business

U.S. corporations are increasingly concerned for the international aspects of their management and operations. But a major in international business in an M.B.A. program is not seen as a good background by most employers.

"Anyone coming out of an M.B.A. program would be out of his mind if he did not have international exposure — a major exposure," one management personnel planning manager told Professor Richard D. Robinson of the Sloan School during a recent survey. Another executive, director of international planning for a large, southern-based, high-technology corporation, complained that "the U.S. does not grow international businessmen. . . . Generally the graduates of U.S. business schools are not prepared for international business."

But when the chips are down, hiring decisions are made on the basis of excellence in the more conventional branches of management. "We are interested in general entrepreneurial talent," Professor Robinson was told by a midwestern, multi-product manufacturer. A bank with wide international interests told him, "We are really looking for someone who can become a qualified banker and, on top of that, has the personality and interest to work satisfactorily in international."

By asking a sampling of business firms about the quality and relevance of international business management education to their personnel needs, Professor Robinson hoped to learn how to design teaching programs for the Sloan School that better met perceived needs. It was a discouraging adventure: "Few corporate executives, other than in some of the large banks, reflected more than casual interest. The corporations simply did not recruit international business majors."

Professor Robinson's conclusion: the importance of having a group teaching and studying international business within a graduate school of business lies in "the internationalizing pressure on the system" which it can exert — stimulating interdisciplinary research, course development, and foreign visitors. The best mission, he said, seems to be "generally arousing student interst in the international dimensions of business."

Weather Forecasting: Lots More Data but Little More Success

Though satellite observations and — especially — computers to analyze weather information have markedly increased the data available to weather forecasters since 1950, there has been only a "modest increase" in the accuracy of the forecasters' predictions in the same period.

M.I.T.'s Department of Meteorology receives all the national weather data available, and for nearly 30 years Professor Frederick Sanders has been teaching students in the Department of Meteorology to use this growing pile of data to make four-day weather predictions. Through that whole period the accuracy of his students' forecasts has remained "remarkably" unchanged, he told members of the Alumni Council early this year.

There have been small gains, perhaps due to computer guidance, in forecasts of minimum temperatures and of the occurrence of precipitation after the first day. Otherwise, computers seem to have helped very little, and now Professor Sanders advises his students to spend more time studying observations (and perhaps even looking out the window) and less working with computer guidance.

Of all weather parameters, forecasts of precipitation quantities remain least satisfactory; forecast accuracy of rainfall amounts is only about half that of other weather features.

What about highly-touted weather satellites? Not much use to New England forecasters, says Professor Sanders, because they "tend to tell us what we already know." (But he admits that satellites may have changed the lives of forecasters on the West Coast because they've added substantially to what was otherwise "sparse knowledge about what is out there in the Pacific.")

XII

Earth and Planetary Sciences

Edward W. Heath, S.M. '59, was recently elected Treasurer of the Dallas Geological Society for 1978–1979. . . . **Clarence D. Davis,** M.D. '35, recently became Professor Emeritus, Obstetrics and Gynecology, Yale University School of Medicine, and is currently Clinical Professor, Reproductive Medicine at the University of California School of Medicine in San Diego. After a long and distinguished career, Dr. Davis recently wrote: "Medicine has taken me far afield from Geology. However, the basic training in study and learning habits has always been of super value to me and my pursuits."

Kenneth L. Larner, Ph.D. '70, has been advanced to Vice President for Research in Western Geophysical Co., in Houston, and was recently elected first vice president of the Society of Exploration Geophysicists. . . . **Thomas Cantwell,** '48, is now an Independent Oil and Gas Operator, with his own company, Independent Exploration Co., in Houston. He is primarily involved in oil and gas exploration and drilling, and is limiting his operations to the United States.

Ely Mencher, Ph.D. '38, as reported in the last issue, died from an embolism on December 11, 1978. He had undergone open-heart surgery earlier. He was a member of the Course XII faculty from 1952 to 1967, and of the C.C.N.Y. Department of Earth and Planetary Science from 1967 until his death. He twice served the latter department as Chairman, from 1968 to 1972 and from 1977 until his death. At City College he helped organize the Geology Department and headed the planning and development of a program leading to a doctoral degree. He would have been 65 on December 13, and was planning to retire at the end of the current semester in order to complete his research on the Paleozoic stratigraphy of northeastern Maine. He leaves his wife Miriam and their son, Frederick, a recent M.S. in marine biology from the University of Hawaii. — **Robert R. Shrock,** Professor Emeritus, M.I.T., Room 54–1026, Cambridge, Mass. 02139

XIII

Ocean Engineering

Stanley H. Rice, S.M. '46, retired from the Coast Guard with the rank of Captain in 1972 and went to work as managing engineer of the Marine Department of Underwriters Laboratories for three years; seeking more variety, he then updated his engineering education by studying for two quarters at the University of South Florida, passed the exams for registration as a professional engineer in Florida, and went into consulting work in Tampa. For the current year he's also associate professor and coordinator of the Maritime Science and Technology Program at Hillsborough Community College, Tampa. . . . **John F. Kalina,** N.E. '50, was promoted in September to be executive vice president of the Stanwick Corp., Arlington, Va.; he's also president of a Stanwick subsidiary, Metier International, Inc., a professional and executive recruitment and search company.

Barry C. Roberts, N.E. '63, reports in from what he calls "the best job in the Coast Guard": he's commanding officer of the U.S.C.G. group and base at Ketchikan, Alaska.

Jay W. Spearman, S.M. '73, is a licensed naval architect, marine engineer, and structural engineer with a general consulting firm in Bellevue, Wash., serving "marine-oriented clients — particularly in the design of facilities at the land-sea interface." He's had jobs in Washington, Alaska, and Saudi Arabia. . . . **Steven L. Smith,** S.M. '73, has joined with his wife Daniell Jarmoluk Smith, S.M. '73 (chemical engineering), to form Construction Engineers, Inc., Russellville, Ark.; the firm specializes in commercial building construction and the Smiths "plan to be active in construction and real estate development."

Jim Ertner, S.M. '75, who has the rank of Lieutenant Commander in the Canadian Navy, is project officer for the design of a new oceanographic research vessel at Canada's National Defense Headquarters in Ottawa. . . . Lieutenant Commander **Thomas E. Fahy,** U.S.N., S.M. '76, is engineer officer of the guided-missile cruiser U.S.S. Horne — as of last November just back from a three-month, 20,000-mile cruise in the South Pacific visiting ports in Australia, New Zealand, Tahiti, and the Fiji Islands. The Horne is based in San Diego.

XVI

Aeronautics and Astronautics

Ed Gallagher, S.M. '50, is a real estate consultant in Ramona, Calif. (near San Diego), specializing in time-share condominiums for San Diego Country Estates. The plan, he writes, is to provide vacation homes which are "exchangeable around the world."

Anthony R. Hollet, S.M. '51, was issued a patent in January, 1978, on "a fundamentally different way to separate solid waste (garbage) for resource recovery." . . . Lieutenant Colonel **Dino A. Lorenzini,** U.S.A.F, Sc.D. '73, is attending the Naval War College, Newport, R.I. . . . From Los Angeles, **Marc L. Sabin,** Sc.D. '73, reports that he is assistant chief of the Reentry Technology Division, Advanced Ballistic Reentry Systems Program, Space and Missile Systems Organization (S.A.M.S.O.); he's the father of Shanan Sabin, born October 2, 1978.

XVII

Political Science

Ted Greenwood, Ph.D. '73, who was promoted to associate professor in the department last spring, is now on leave as senior policy analyst in the White House Office of Science and Technology Policy. He joined the department as assistant professor after completing his doctorate and at the same time joined the Policy Studies Group of the M.I.T. Energy Laboratory. . . . **Howard E. Wolpe,** Ph.D. '67, defeated an incumbent Republican to win election to the House of Representatives from the third Michigan district (Lansing) last November. Before entering politics in 1972 (when he was elected to the Michigan legislature), Dr. Wolpe taught at Western Michigan University, where he maintained his interest in political and economic change in Africa which was reflected in his M.I.T. thesis on the politics of development in Nigeria. For two years beginning in 1976 he was local representative (in Lansing) for Michigan Senator Donald W. Riegle, Jr.

Judith A. Chubb, Ph.D. '75, is now assistant professor of political science at Holy Cross College, Worcester. . . . **Richard A. Rettig,** Ph.D. '67, is the author of *Cancer Crusade: The Story of the National Cancer Act of 1971* (1977: Princeton University Press).

Twelve political and social scientists are working as visiting scholars and researchers at the Center for International Studies during the current academic year:

☐ Lieutenant Colonel **Robert M. Clewell,** U.S.A., evaluating U.S. strategic nuclear policies in relationship to defense requirements and arms control objectives.

☐ Professor **Herbert S. Dorick,** associate director of the Annenberg School of Communications at the University of Southern California, working with the center's research program in international communications policy.

☐ Professor **Michael Handel** of the Department of International Relations, Hebrew University, Jerusalem, working on the impact of new weapons technology on strategy, tactics, and the balance of power.

☐ **Nancy K. Hetzel,** research associate in the Dartmouth College Environmental Studies Program, working with the program on international environmental issues.

☐ **Roberto Hukai,** head of the Reactor Physics and Projects Department at the Institute of Atomic Energy, Sao Paulo, Brazil, working on the Brazilian nuclear program and its international implications.

☐ Professor **Baruch Kimmerling** of the School of Economics and Social Sciences, Hebrew University, studying Arab-Jewish community relations and the relationship between Zionist ideology and Israel's economic structure.

☐ Professor **Ian Lustick** of the Department of Government, Dartmouth College, studying decision systems in the context of organization theory and comparative business theory.

☐ **Brian Martin** of the United Nations Environment Program, working on a scientific, economic, and policy survey of marine pollution monitoring and assessment.

☐ **C. V. Narasimhan,** under-secretary-general for interagency affairs at the United Nations, writing an historical study of the U.N. system and its contributions.

☐ Lieutenant Colonel **Wolfgang W. E. Samuel,** U.S.A.F., studying the implications of new developments in science and technology for the military strategy of the western alliance.

☐ Professor **Alden Speare** of the Department of Sociology at Brown University, studying urbanization in East Asia.

☐ **Hartojo Wignjowijoto,** working on financial aspects of energy models with emphasis on managing exhaustible natural resources.

XIX

Meteorology

Lance F. Bosart, '64, is on leave this year from his faculty post at the State University of New York in Albany to serve as visiting associate professor in the department at M.I.T.; he's doing special research on rainfall prediction problems.

XX

Nutrition and Food Science

Barbara A. Underwood, who is resident coordinator and program assistant at the World Hunger Program of the United Nations University, has been promoted from assistant to associate professor in the department. Dr. Underwood came to M.I.T. in 1978 from Pennsylvania State University, where she was assistant professor of nutrition; she holds degrees from the University of California at Santa Barbara (B.A. 1956), Cornell (M.S. 1958), and Columbia (Ph.D. 1962).

XXII

Nuclear Engineering

From **Paul Kolody,** S.M. '72: "After having spent five years on nuclear-powered submarines, I have moved on and now work for the Westinghouse Research and Development Center in Pittsburgh in the energy Systems Analysis Group." . . . From **Thomas E. Eaton,** S.M. '74: "I am currently on leave from the University of Kentucky to work as a fellow of the Advisory Committee on Reactor Safeguards in the U.S. Nuclear Regulatory Commission."

Thomas E. Murley, Sc.D. '65, is director of reactor safety research at the U.S. Nuclear Regulatory Commission. . . . **Stephen C. Jones** S.M. '73, is vice president and general manager of the Los Angeles Division, Todd Pacific Shipyards Corp. . . . **Lawrence J. Metcalfe,** S.M. '75, senior engineer for EDS Nuclear, Inc., San Francisco, presented a paper on the contempt code at the San Diego meeting of the American Nuclear Society, June, 1978, and participated in a poster session at the A.N.S.-E.N.S. meeting in Brussels, October, 1978.

The 1978 Fields Medalist, Daniel V. Quillen, Professor Mathematics at M.I.T. "One studies his work not only to be informed but to be edified," writes Professor Hyman Bass of Columbia University. (Photo: Margo Woodruff from the M.I.T. News Office)

Quillen: A Special Talent for Unifying Mathematics to Solve Hard Problems

If there is the equivalent in mathematics to the prestige associated in adjacent scientific disciplines with the Nobel Prize, then it belongs to the Fields Medal of the International Congress of Mathematicians, won last summer by Daniel G. Quillen, 38 years old, Professor of Mathematics who has been at M.I.T. since completing his Ph.D. at Harvard in 1964.

Professor Quillen's work is in the field of topology — at best hard to describe to nonmathematicians. Here are some excerpts from the essay in tribute to Professor Quillen by Professor Hyman Bass of Columbia University in *Science* for November 3:

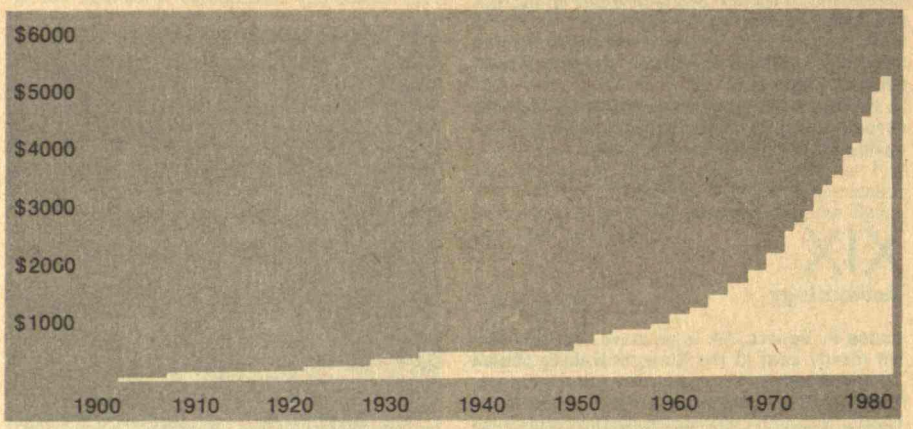
"Topology is what underlies the various modern fields of geometry. The geometrical objects of its study are called topological spaces, and by the middle 1930s an arsenal of rather sophisticated algebraic techniques had evolved for solving the geometric problems of topology. . . .

"In order that these algebraic techniques not remain a special craft, the private reserve of a few virtuosos, it was necessary to put them in a broad, coherent, and supple conceptual setting. This was accomplished in the 1940s and 1950s. . . . The result of this enterprise of simplification, unification, and axiomatization was a methodological instrument that could be applied far beyond the setting of its birth; we call it homological algebra. It intruded naturally and fruitfully into every major area of mathematics and eventually required, in turn, a still more abstract and general conceptualization of its own techniques. This led to what we now call the theory of categories and functors.

"Professor Quillen is one of the greatest masters of these homological and categorical techniques. He has used them with stunning originality to treat a variety of problems. He has even invested them with a kind of naive geometric character which helps remove the shroud of ponderous formalism that has estranged many earlier mathematicians. . . .

"Mathematical talent tends to express itself either in problem-solving or in theory-building. It is with rare cases like Professor Quillen that one has the satisfaction of seeing hard, concrete problems solved with general ideas of great force and scope by the unification of methods from diverse fields of mathematics. Professor Quillen has had a deep impact on the perceptions and the very thinking habits of a whole generation of young algebraists and topologists. One studies his work not only to be informed but to be edified."

Everything costs more these days — including an M.I.T. education. The chart at right shows the rising cost of tuition since 1900 — it even went up during the Depression, though usually it's not far from the rate of inflation. M.I.T. is always among the most expensive colleges — but that doesn't seem to discourage potential students: this year also boasts 5,220 applications for admission — the most ever.



Tuition Up 8.5% to $5,100: "Too Damn Much," Says Tom Curtis; but "We Can Wear Sweaters"

Tuition will rise $400 in 1979–80, to $5,100. That's an increase of 8.5 per cent.

In addition, the mandatory health fee will go up $13 to $200 next fall, and it will be included in the stated tuition. Thus next year's tuition will be listed as $5,300 in the catalog. (The health fee assures ambulatory and infirmary care for all students by the M.I.T. Medical Department.)

Everyone expected an increase. Paul E. Gray, '54, chancellor, forecast a deficit in 1979–80 operations in his report to the faculty on financial affairs last fall *(see December/January, pp. A15–A16),* and he warned then of a likely tuition increase. When the figure was announced late this winter, he referred to "increases in wage and salary costs, the prices of services, of energy, and of materials and equipment essential to the operation of the Institute. . . . We have sought to keep these costs under control while maintaining the quality of our academic programs and supporting services," Dr. Gray said.

But "there are no responsible alternatives" to a tuition increase "if M.I.T.'s quality is to be maintained," he declared.

Most students seemed resigned to another in the series of tuition increases which have come annually since 1970. Thomas A. Curtis, '80, writing in *The Tech,* agreed that "if M.I.T. continues to cut programs as it has done for the last several years educational quality will be . . . severely damaged." But he concluded that "this tuition increase is truly too damn much," and he called for "creative ways to cut expenses without cutting quality."

Even in the middle of a prolonged cold wave, Mr. Curtis had a proposal: "cut thermostats a few more degrees. My room at M.I.T. is kept warmer than my room in South Carolina. We can stand to wear sweaters," he wrote.

Virginia C. Grammer, '47, went back to school in the division for Study and Research in Education at M.I.T. in 1975; when she finished her master's degree in educational technology two years later she was invited to manage the computer system and teach in the computer laboratory of the Mario Umana Harbor School of Science and Technology — the Boston "magnet school" associated with M.I.T. The computer is the central core of technical work at Umana; the students have "caught the bug," says Louis J. Cicolari, Umana's head computer science teacher, and he and Ms. Grammer are now looking for part-time and summer jobs for students who want to try out their computer skills and gain confidence in using them. With Ms. Grammer in the picture are two Umana seniors — Michael Mancusi (left) and James B. Willis. (Photo: Calvin Campbell)

Infected with Computers, Umana Catches the Bug

When M.I.T. began its work to help make a "magnet school" for students interested in technical careers at the Mario Umana Harbor School of Science and Technology in East Boston, the faculty who were advising on the school's curriculum made an early, fundamental decision:

The central core for any technical program should be the computer.

A good decision. It's gone so well that now everyone connected with the computer teaching program at the Umana School is busily trying to find part-time "externships" and summer jobs for students who are "turned on" to computers and ready to make career commitments int the field.

The original idea, according to Professor Myron Tribus, director of the Center for Advanced Engineering Study, was that using computers could "revolutionize the kids' attitudes toward learning. It's demanding, but it's fun.

"It was our idea to infect this school with computers," recalls Professor Tribus.

The result is now "a group of kids who have caught the bug," says Louis J. Cicolari, the head computer science teacher at Umana School. They're ready to try out and expand their skills in business, industrial, or office settings, and they need "the kind of confidence-building that such opportunities can provide," says Mr. Cicolari.

An example is Michael Mancusi of East Boston, who's now a Umana School senior. He worked last summer at the Air Force's Electronics Systems Division at Hansom Field. "I actually did computer operating," he says with enthusiasm. "I was doing and learning at the same time and getting paid for it." Michael will probably return to Hanscom next summer and go to Northeastern University in the fall.

The Umana School's computer program began — as a stop-gap measure — with ten computer terminals tied to M.I.T.'s Multics system. Now Umana has its own system — a PDP 11/34 with 16 terminals and other hardware — the largest instructional set-up in Boston and probably in the state. Virginia C. Grammer, S.M. '77, is computer system manager and teacher at Umana, and Maureen Hart, '78, is a computer laboratory assistant.

Health Effects of Fossil Fuels

What are the dangerous emission products of fossil fuel combustion? What is their real potential for mutagenic and/or carcinogenic activity? And what can be done to effectively and economically control them?

These questions form the agenda for a five-year program in a new Center for Health Effects of Fossil Fuels Utilization, established at M.I.T. with $3.8 million from the National Institute of Environmental Health Sciences. Its significant feature will be collaboration among experts in combustion engineering, chemical analysis, and tox-

icology, fields in which interrelated studies are at best uncommon.

The Center's director is Professor Gerald N. Wogan, a distinguished toxicologist in the M.I.T. Department of Nutrition and Food Science; he'll be assisted by Professor Jean F. Louis of the Department of Aeronautics and Astronautics as Associate Director. The Center is a joint project of the M.I.T. Energy Laboratory and the Harvard-M.I.T. Division of Health Sciences and Technology.

International Congress on Science and Religion

Some 500 world leaders in science, religion, and social policy will convene at M.I.T. in July for a World Conference on Faith, Science, and the Future called by the World Council of Churches. It will be the first ecumenical conference in which scientists and technologists predominate, the largest ecumenical meeting held in the U.S. since 1954.

The purpose, according to Metropolitan Paulos Gregorius, Head of the Syrian Orthodox Church of South India who will be the conference moderator: to reconcile scientific progress and technological advance with religious faith and ethics.

Professor David J. Rose, Ph.D. '50, who is a member of the World Council of Churches' working group for the conference, emphasizes that it will "not be conference of elite scientists talking about an elite science as if it were God-made." M.I.T.'s relationship to the meeting is that of host, not sponsor; indeed, U.S. participation will be so limited (to 40) that few if any members of the Institute community — other than Dr. Rose — can be assured of participation.

The two-week conference will open on July 12; it will be preceded by a student meeting on the same issues at Wellesley College beginning early in July.

The Richards Lobby

The bas-relief honoring Ellen Swallow Richards, who became M.I.T.'s first alumna in 1873, has now been refurbished, and the lobby of the Building 4 entrance to Killian Court, where the bas-relief is located, is now renamed in her honor.

Ellen Swallow entered the Institute in 1871 after graduating from Vassar College, and she was associated with M.I.T. for the rest of her life. Two years after receiving her degree in chemistry, Ms. Swallow was married to professor Robert H. Richards, a member of the first graduating class who founded and was the first president of the Alumni Association.

High Ratings for the Faculty

"Name the five departments nationally that have the most distinguished faculties in your discipline" — a request late in 1977 of a cross-section of faculty members in American universities by Professor Seymour M. Lipset of Harvard and Everett C. Ladd, Jr., of the University of Connecticut.

The results, according to the *Chronicle of Higher Education:* M.I.T. ranked among the top nine (or fewer) institutions in every field except psychology and philosophy in which the Institute grants graduate degrees.

The M.I.T. faculty was ranked first in engineering in the nation, second in economics, fourth (to Harvard, Caltech, and Berkeley) in physics, fifth in chemistry, sixth in mathematics, seventh in the biological sciences, eight in business, and ninth in political science. Some 32 per cent of all those asked picked M.I.T. as the nation's top engineering school, and 39 per cent (tied with Harvard) ranked the Institute at the top in economics.

$1 Million from Kresge, If . . .

The Kresge Foundation will give M.I.T. $1 million in January, 1981, if the balance of the funding for a new health sciences, technology, and management center is complete.

It's a challenge grant which "comes at a critical time," says Howard W. Johnson, chairman of the M.I.T. Corporation, as the Leadership Campaign seeks to complete this major project. The $29 million health center will be built on Carleton St., Cambridge, just behind the 100 Memorial Drive apartment house; two major buildings are now in the design stage.

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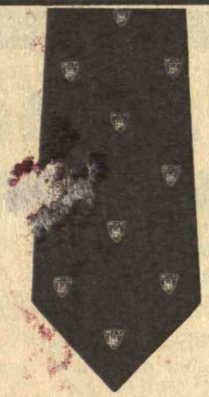

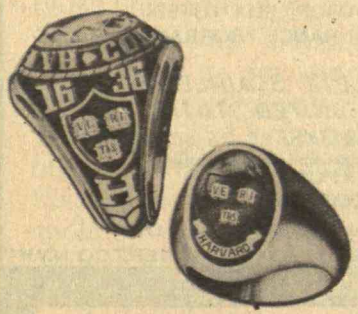

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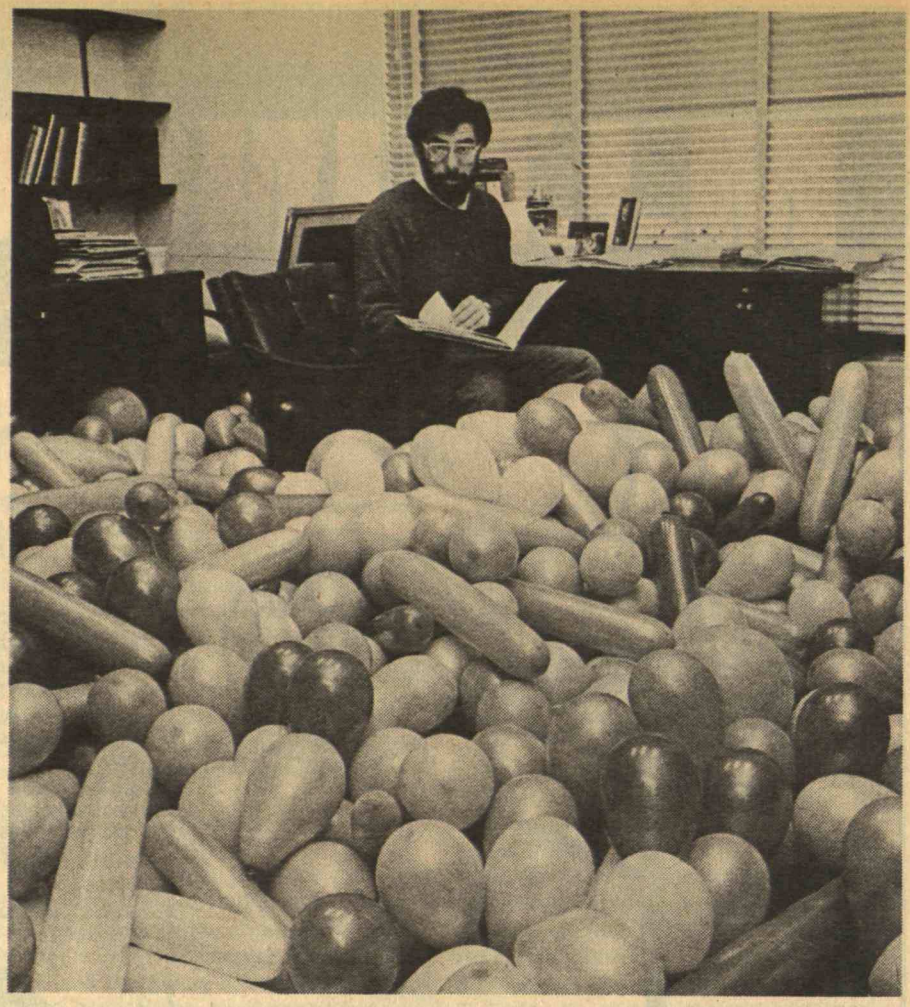
"We're a friendly department," said a philosophic Professor Robert J. Silbey (chemistry) when he returned from Europe late in December to find his office filled with 1,000 inflated balloons — all sizes, shapes, and colors. The culprits turned out to be two of his graduate students – no special reason, they said. To clean up the mess, Professor Silbey mounted a direct attack which took only 30 minutes and brought people on the run from all over the corridor: "I stuck a scissors into each balloon." (Photo: Calvin Campbell)



watch relying on its balance spring, or a nuclear clock, such as radio-carbon dating or estimation based on radioactivity of rock for geological time-scales, one is inevitably basing one's measurement on a source of time affected by the gravitational red shift. Combining this with (v), it follows inescapably that *time is slower at the foot of a tower than at its top.*

Thus these considerations drive the disintegration of any universal time concept further beyond what already followed from special relativity. Time must never be thought of as pre-existing in any sense; it is a *manufactured* quantity. In special relativity one learns that each inertial observer manufactures his time, which is as perfect for him as that of any other inertial observer is for that second observer, but the two times are in no sense identical. However, whereas the discrepancy in time-keeping between inertial observers related to their relative speed and vanishes if they are at relative rest, in gravitational theory we have a time discrepancy between observers at relative rest to each other but "higher" or "lower."

Falling Down a Shaft

Nothing in this discussion has had any relation to a relative acceleration of neighboring particles. Thus no intrinsically observable property of the gravitational field is involved. Accordingly the entire Einstein shift can be abolished by falling freely. Put the tower in a box falling freely down a shaft and remove the rotating wheel of mirrors. The compensation for the red shift now occurs because during the time the light takes to travel "up" (h/c), the box accelerates to a velocity of gh/c. Thus at the moment a package of light arrives, the top has this velocity relative to the motion of the bottom when the package of light started out. The consequence is a fractional blue shift of v/c, or gh/c^2, cancelling the gravitational red shift. If follows that in the freely falling box there is no gravitational effect, as is of course right for this condition of weightlessness.

As soon as an extended volume is considered, the observable of the gravitational field manifests itself. Relative accelerations will appear and the total abolition of the field can no longer be achieved through falling freely. Indeed, if we consider an observer falling freely and vertically in one spot on the earth, his motion cannot counterbalance the red shift observed a little distance away between the top and the foot of a tower. Thus there is an intrinsic connection between Einstein shift and the observable of the gravitational field. A detailed theoretical analysis shows that this connection requires a non-Euclidean geometry, as found originally by Einstein, and presented in 1916 in his theory of general relativity. He used a somewhat different approach from the one presented here.

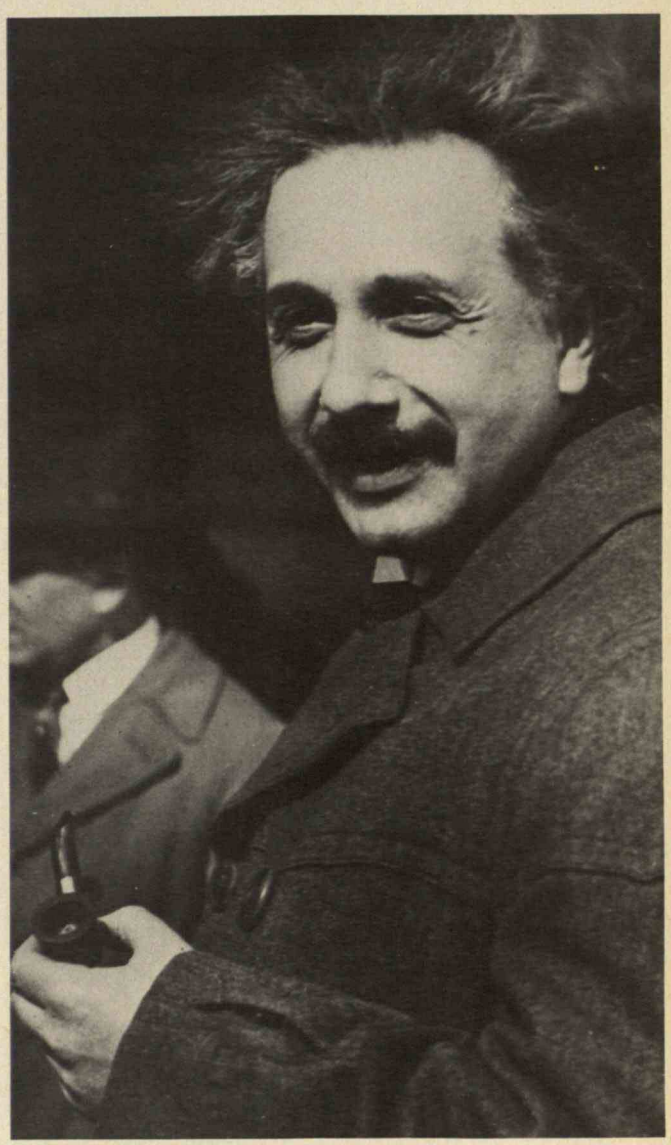
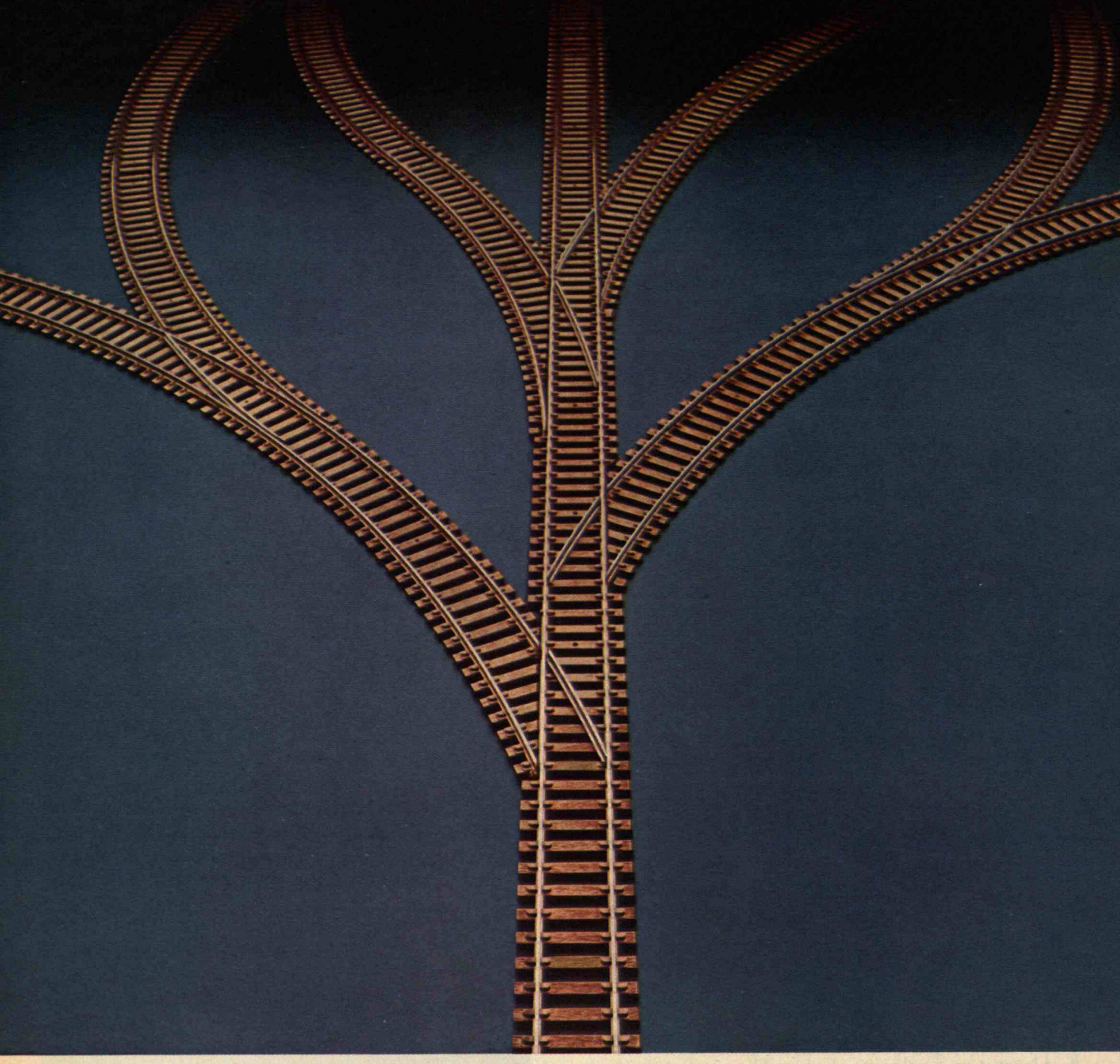


Photo of Albert Einstein courtesy of M.I.T. Historical Collection

Herman Bondi is Chief Scientist in the U.K. Department of Energy and Professor of Mathematics at King's College, London. His publications reflect his stature as a theoretical cosmologist: he is author, *inter alia,* of *Cosmology; The Universe at Large;* and *Relativity and Commonsense.*



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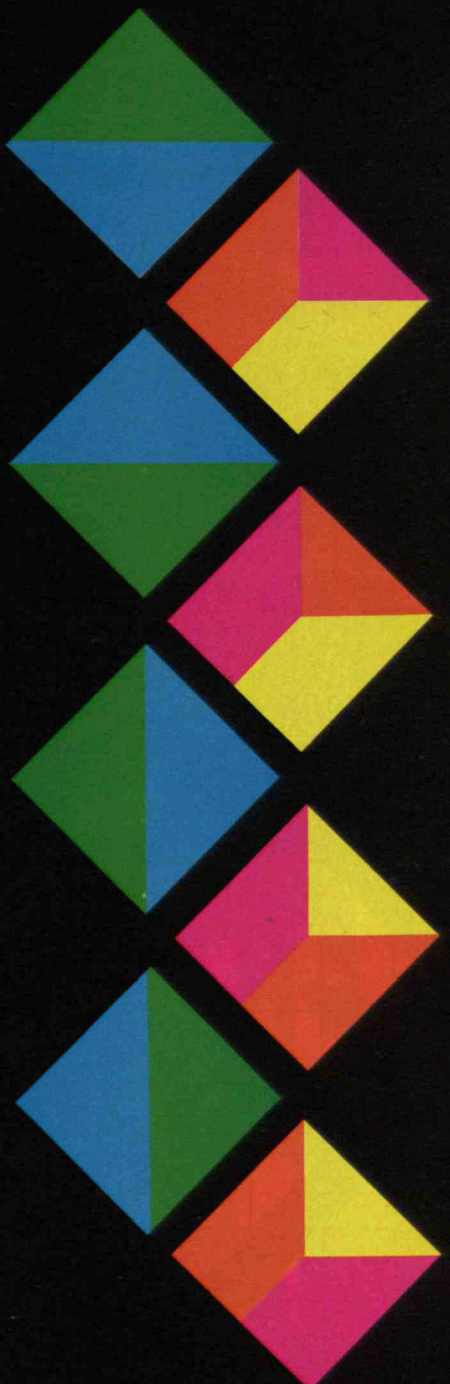


The symbols for integers mod 8 from the design on the cover of this issue.

Clock arithmetic illuminates the creative interplay between art and math — and helps to enrich both.

Mod Art: The Art of Mathematics

by Susan Jane Morris

Many of us perceive a strong connection between mathematics and art, but the relationship between the two endeavors may be far deeper than is commonly supposed. The link between artistic creation and mathematics does not limit itself to the science of perspective drawing or even to the dazzling tesselations of M. C. Escher. Mathematics is a creative process and a search for symmetry and beauty as surely as is painting itself.

For the last five years I have been involved in a project entitled "Mod Art." Although this work deals specifically with a transformation of modular arithmetic into artistic designs, I believe that mod art provides a fundamental lesson concerning the similar aesthetic values of mathematics and art. Showing exactly how a mod art pattern is created also illustrates some of the rich interplay that exists between the mathematics and the art.

Modular arithmetic is actually a concept with which we are all quite familiar. For example, if it is ten o'clock, then three hours later it will be one o'clock (and not, via simple addition, thirteen o'clock). Modular arithmetic is really nothing more than a "jazzed up" version of clock arithmetic and turns out to be an invaluable technique for number theorists.

For the sake of rigor, we use the term *integers modulo n* which we define to be the finite set $\{0, 1, 2, \ldots, n-1\}$, together with an addition and a multiplication acting on that set. Modular addition and multiplication differ from the ordinary operations on integers in that, after obtaining the "conventional" result, we "cast out" the *modulus n* by subtracting it repeatedly from the result until the latter is brought between 0 and $n-1$. This is also equivalent to dividing the answer by the modulus and retaining only the integral remainder of this division.

As an example, integers mod 4 is the set {0, 1, 2, 3} with the complete addition and multiplication tables given by:

+	0	1	2	3
0	0	1	2	3
1	1	2	3	0
2	2	3	0	1
3	3	0	1	2

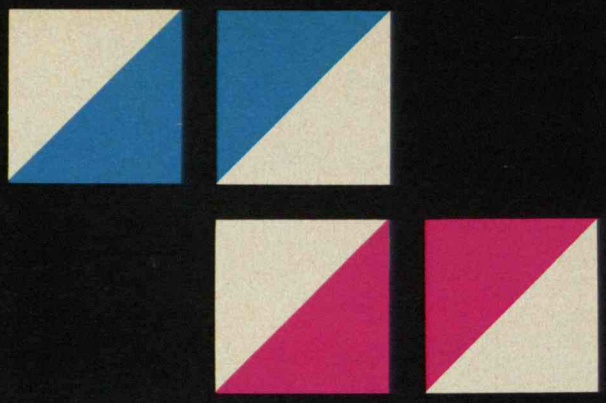
×	0	1	2	3
0	0	0	0	0
1	0	1	2	3
1	0	2	0	2
3	0	3	2	1

Note that $1 + 2 \equiv 3 \pmod 4$ since 3 is itself between 0 and $4 - 1 = 3$, and $3 \times 3 = 9 \equiv 1 \pmod 4$ since 9 has a remainder of 1 when divided by 4. The three horizontal bars indicated a *congruence* relation instead of ordinary equivalence.

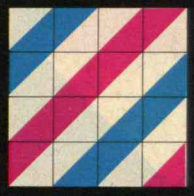
Once equipped with modular arithmetic, creating a mod art design is actually a very simple procedure: we merely pick a modulus, one of the two operations (i.e., addition or multiplication), and then substitute distinct symbols for each of the numbers appearing in the table for the chosen operations. Thus if we pick addition modulo 4, we have the table:

0	1	2	3
1	2	3	0
2	3	0	1
3	0	1	2

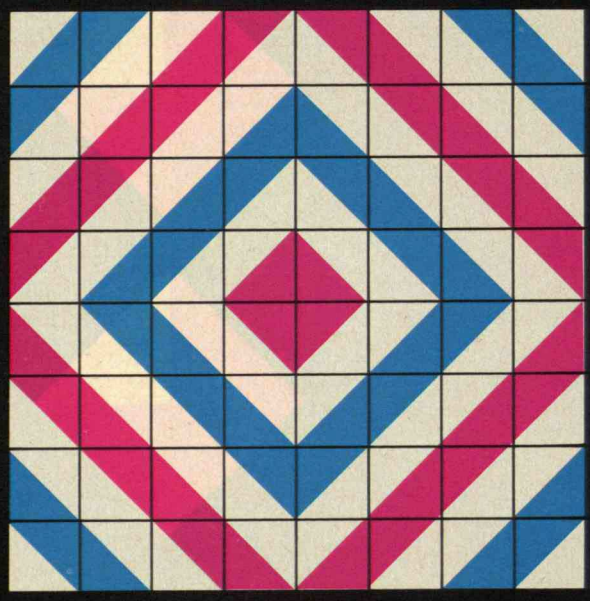
If we choose the following symbols:

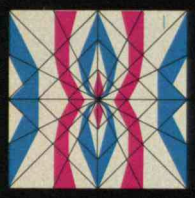


we create a mod art pattern that looks like:



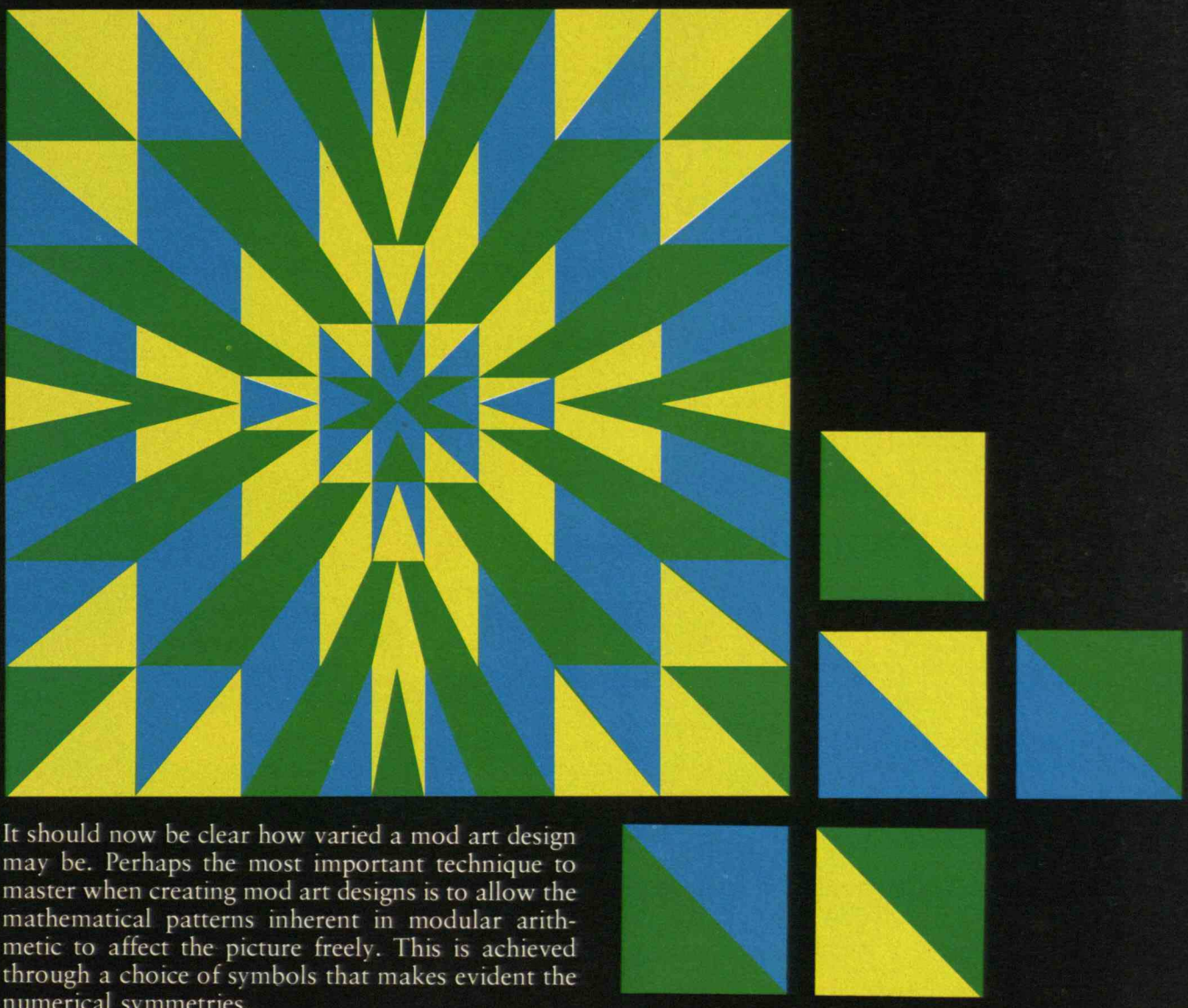
If we wish, we may stop here. However, a few additional techniques provide us with a great variety of possible patterns from this basic design. Instead of the simple grid above, we may use a four-quadrant complex grid, placing the basic pattern in any one of the quadrants and then repeating it in each of the other three quadrants, or else reflecting it through the axial lines, which gives greater symmetry. This reflection process applied to the design created above may be seen below (the original pattern appears in the upper left quadrant).





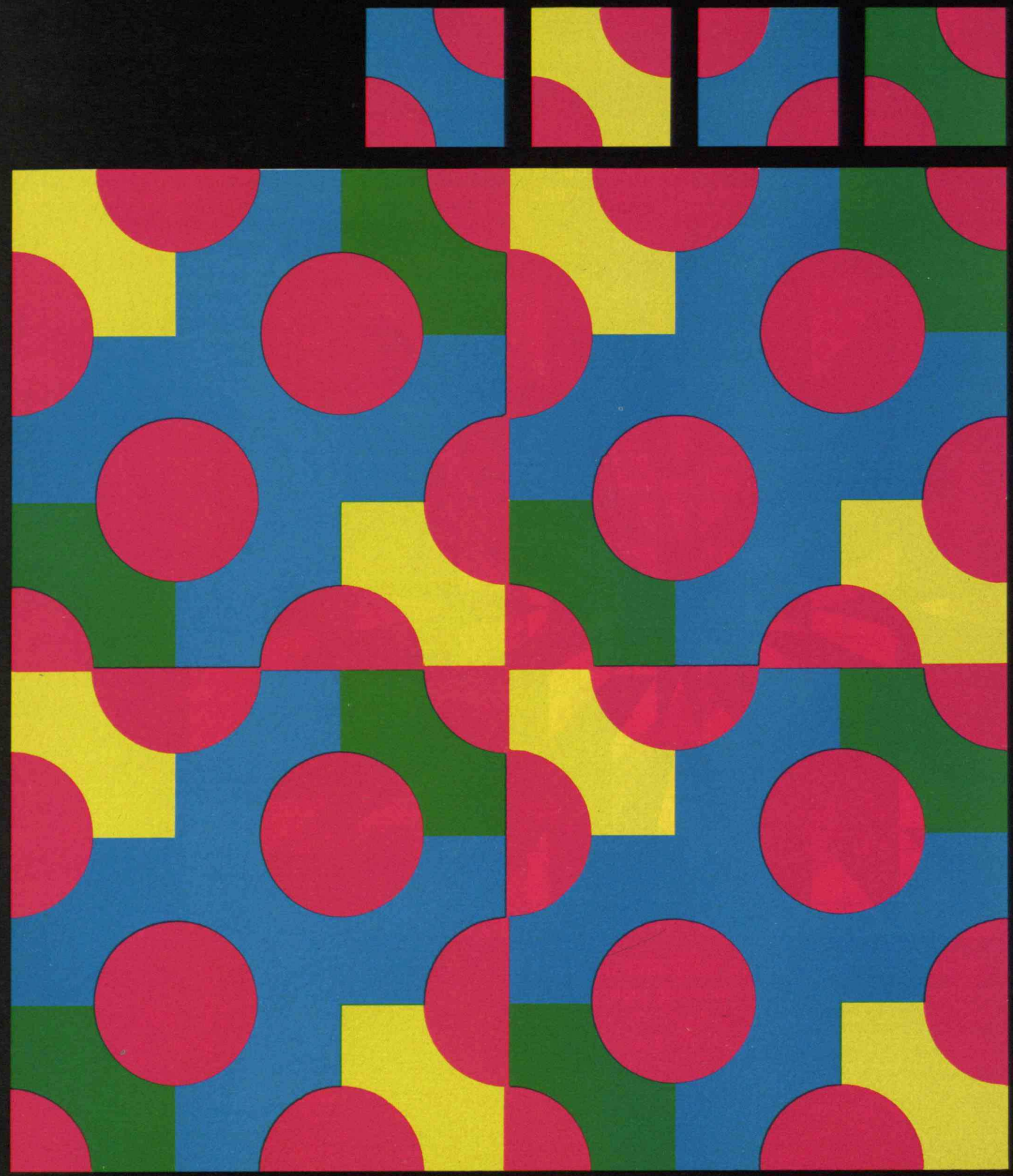
Note that we needn't employ regular square grids for our designs. We may use grids whose cells elongate or shrink in either direction (like logarithmic graph paper). In fact, the grid may be any weird topological variant at all:

first design created above, we may emphasize this pattern by choosing appropriate symbols. Equally interesting effects occur when we choose symbols which oppose the diagonal symmetries of the addition tables (see below).



It should now be clear how varied a mod art design may be. Perhaps the most important technique to master when creating mod art designs is to allow the mathematical patterns inherent in modular arithmetic to affect the picture freely. This is achieved through a choice of symbols that makes evident the numerical symmetries.

Addition tables display clear diagonals running from lower left to upper right corners. As with the



With multiplication, we find situations somewhat more subtle and complex. One intriguing aspect is the distribution of odd and even numbers in the multiplication table for an even modulus. For example, see multiplication mod 8 below (the odd numbers are boxed).

×	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	[1]	2	[3]	4	[5]	6	[7]
2	0	2	4	6	0	2	4	6
3	0	[3]	6	[1]	4	[7]	2	[5]
4	0	4	0	4	0	4	0	4
5	0	[5]	2	[7]	4	[1]	6	[3]
6	0	6	4	2	0	6	4	2
7	0	[7]	6	[5]	4	[3]	2	[1]

By designing contrasting symbols for odd and even numbers, we may achieve a very striking and handsome effect (see cover).

Only a small sample of the diversity of patterns possible from mod art is presented here. Deeper studies concerning specific moduli, prime moduli, or the group properties of modular arithmetic lead to new patterns which directly display mathematical beauty. In fact, the reciprocity between the math and art is itself an exciting creative process. Some of the mathematical truths connected with modular arithmetic are discovered only after attempting to create a design, and some of the most attractive patterns are those which clearly exhibit some mathematical fact.

Mod art may be taught with gratifying results to almost any group; I have successfully introduced it to fifth-graders. Mod art provides not only a pleasant setting in which to learn some math, but also an opportunity to experience directly, at least in some small measure, the creative process in mathematics and to realize how close such an experience is to artistic creation.

Suggested Readings

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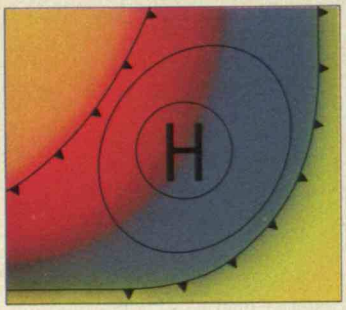
Troutman, Andria P. and Sonia D. Forseth: "Using Mathematical Structures to Generate Artistic Designs." *The Mathematics Teacher*, May, 1974, pp. 393–398.

Susan Jane Morris is a senior in pure mathematics at M.I.T. where she has been president of the Undergraduate Math Club for the last two years. Her mod art project, begun at the Lenox School in New York City, received a gold medal in the 1974 Greater Metropolitan New York Math Fair. The author wishes to express her gratitude to Gerda Talesnik and Robert Banck, "without whom mod art would never have blossomed."

When the Environmental Protection Agency (EPA) originally set the standard for ozone in air at 0.08 parts per million, it assumed that this major smog ingredient is formed primarily from man-made hydrocarbons and nitrogen oxides reacting in sunlight.

Since then, however, air quality studies have revealed frequent rural violations of that standard. The suspected sources of ozone are the stratosphere, drift from urban areas, and, indirectly, natural vegetation. To evaluate each source, scientists at the General Motors Research Laboratories analyzed air at five rural sites.

Average Beryllium-7 Concentrations in High Pressure Systems at Busick, N. Carolina



■ ^{7}Be = 372 disintegrations/min.
■ ^{7}Be = 261 disintegrations/min.

What did they find? Not only was the ozone standard violated at all five sites, but *average* ozone levels at those sites exceeded average levels in urban areas previously monitored (although *peak* urban levels were higher).

Furthermore, using beryllium-7 as a tracer of stratospheric ozone, our scientists found that such ozone is distributed *throughout* high pressure weather systems and, in fact, is most concentrated in the trailing sector.

This evidence refutes the assumption that stratospheric ozone contributes only near the leading edge of these systems, where measurements show lower ozone levels. And it thus indicates that the stratospheric contribution to ground-level ozone has been seriously underestimated.

The results aren't all in. But enough has been learned to question a goal requiring cleaner air than what nature itself provides.

Recently, based on a reassessment of health effects data, the EPA raised the ozone standard to 0.12 ppm — a level still very close to the natural ozone level.

Mother Nature will take her own course no matter how she scores on EPA tests. It's up to us — industry *and* government — to adapt to her standards.

We currently have openings for Ph.D.s in engineering or the physical, mathematical, or biomedical sciences. If interested, please send your resume to: GMR Personnel, Dept. 316. An Equal Opportunity Employer.

Some Institutional Problems of the U.S. Nuclear Industry

by Timothy L. Montgomery and David J. Rose

The U.S. nuclear option faces social opposition, financing difficulties, and unpredictable government attitudes. Technology alone can therefore not save it.

Nuclear reactors run better today than ever before, and in many parts of the country nuclear power costs appreciably less than its alternatives. Why, then, when the future of nuclear power should appear brighter than ever, is the domestic light water reactor (LWR) industry in grave danger of withering away?

Public safety, nuclear proliferation, and economic considerations have emerged as focii in the nuclear power debate. Advocates and critics of the nuclear option exchange rhetorical barrages, selectively ignoring various issues while painting all futures not to their liking in apocalyptic hues. Economic, regulatory, and social and institutional problems have greatly increased the uncertainties facing utilities considering nuclear power.

For nearly two years the Massachusetts Institute of Technology's Department of Nuclear Engineering and Energy Laboratory have been examining the current health and future prospects of America's LWR business; this article is a summary of a part of that effort. The issue of nuclear proliferation has been left for argument elsewhere; we discuss only the domestic use of civilian nuclear power by a nation which already makes nuclear weapons. Likewise, we do not attempt to resolve the philosophical question of whether technology is inherently good or evil. This issue is now being debated in many arenas; here we accept the premise that nuclear power is a conditional good. Our article analyzes the social and institutional sources of the uncertainty now haunting nuclear power and what options exist for keeping the American nuclear energy sector alive.

The Proliferation of Uncertainty

We see three major reasons for the current situation:

☐ *Unpredictable government attitudes.* A nuclear power plant today can cost upwards of two billion dollars and often requires a utility to commit double its entire historical investment to construction. Retroactively applied changes in federal regulations, however, might require the utility to backfit at great additional expense a completed nuclear plant, making even a new generating facility suddenly uneconomical to operate in comparison with other options. Utility decisionmakers are greatly unnerved by the spectre of unanticipated regulatory changes that create unpredictable escalations in costs. New plant orders have plummetted.

Such specific examples are easy to find, but the problem is far more general. Despite repeated assurances that it desires a healthy LWR industry, the federal goverment has neither made a firm commitment to the domestic use of nuclear power, nor has it announced a comprehensive national plan for the disposal of the nuclear wastes — the various radioactive by-products of nuclear fuel consumption. Utilities do not know what is to be done with the spent fuel that they now are storing temporarily on-site, and thus cannot estimate their share of its future disposal cost. Continued government procrastination gives the utilities little confidence that such issues will be resolved in the foreseeable future.

To be sure, utilities anticipate regulatory changes as technology and our understanding of environmental and other social effects improve, but the lack of a defined philosophy underlying the nuclear regulatory process prevents them from predicting what direction those changes are likely to take. Utilities, for example, cannot anticipate how economic and safety considerations will be weighed in the future. Each parameter needs to be defined by its relation to the others so that the various dimensions of nuclear power can be considered as tradeoffs, rather than in isolation. Until the philosophy underlying regulation is clarified, costs and rates of return will remain too unpredictable for most utilities to justify risking the

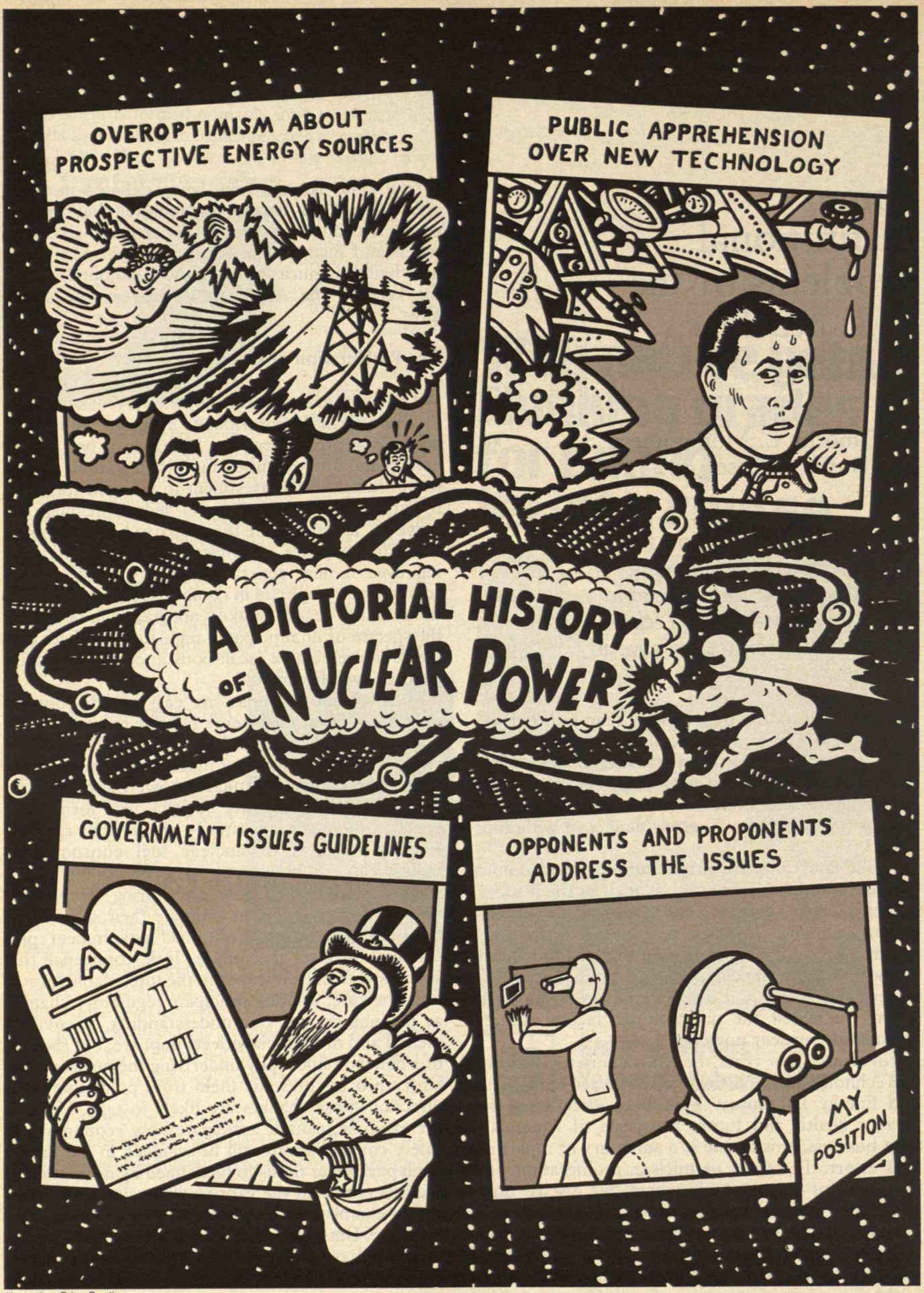


Illustration: Brian Bradley

huge investment needed to build a nuclear reactor.

Most of the uncertainty surrounding government nuclear policy stems from the conflicting signals sent out by the many bureaucracies with authority over nuclear power. No mechanism exists that might integrate the piecemeal regulatory efforts. Partial blame for this lack of integration stems from the 1974 decision to replace the Atomic Energy Commission (A.E.C.) with the Nuclear Regulatory Commission (N.R.C.) and the Energy Research and Development Administration (E.R.D.A.). The decision itself had an obvious justification. By the early 1970s the A.E.C.'s internal contradictions had become apparent. An active but unadvertised policy of supporting its supporters and harrassing its opponents had developed, and the agency showed increasing intractability concerning changes in its policies (for example with respect to breeder reactor development). On the rationale that a single agency simultaneously regulating and promoting nuclear power represented a conflict of interest, the two functions were given to independent agencies. This separation solved some of the aforementioned problems, but soon gave rise to others.

In Hegelian logic, two ideas, a thesis and its antithesis, merge to form a new, more complete synthesis which then confronts yet another antithesis. At each step in the process, conflicting positions merge to form new ideas which reconcile both and reflect a higher intellectual level.

With regulation decoupled from the development of nuclear power, the Hegelian process is perverted. E.R.D.A. and the N.R.C. are unshackled from each other: both are free to pursue wholly independent goals without regard for the effects their actions have on one another. The N.R.C., for example, does not attempt to weigh safety or environmental factors with economic considerations. With neither actor seeking a balance and no judge to reconcile opposing interests, the regulatory activity takes on the character of trial by combat. Rather than a cooperative pursuit of the public interest, there exists instead a bureaucratic tug-of-war.

Out of this chaotic arrangement has resulted a myriad of regulatory-induced technical problems. Power maneuvering restrictions limit certain fuel cycle improvements. The fuel adjustment clause encourages the use of high cost fuel and thereby makes LWRs artificially unattractive. Plant construction is repeatedly started and stopped, as has recently been happening at the Seabrook, N.H., power plant site. Possible technical improvements are not pursued by the nuclear vendors out of fear that the regulatory agencies will order such improvements backfitted into all existing systems.

□ *Intervention by Critics.* A second major source of uncertainty among the utilities is the virtual guarantee of intervention against plant construction and operation by the critics of nuclear power. Partly through the media and partly through intervention in the courts, critics have nurtured a climate of social unacceptability around nuclear power. Because the future of America's nuclear option requires increasing its public acceptability, both the overt aspects and the implicit social content of public opposition deserve careful attention.

Anti-nuclear sentiment has arisen from a variety of sources. The legacy of atomic weapons; public fear of the unknown; general public distrust of government, industry, and technology; and the focusing of environmentalists on nuclear power all have contributed.

In particular, the environmental movement's emphasis on studying the hazards of nuclear power has produced an imbalance of information regarding the dangers of nuclear energy vis-à-vis those of its alternatives. This imbalance of information has both exacerbated public fear of nuclear power and promoted an unjustified insouciance concerning the hazards of other energy sources — coal, for example.

Then, too, there is the historical lack of responsiveness shown by government and industry to the social issues surrounding the production of energy. In this climate, the warnings made by opponents of nuclear power cast doubt on the safety claims long maintained by the A.E.C. and the nuclear industry and contributed to a decline of public confidence in the government decisionmaking process. Uneducated to the complexities of energy issues, the distrusting public is easily molded by the sharp rhetorical tools of anti-nuclear groups.

Public opposition to new technologies is a historical phenomenon; the automobile and the airplane, to name just those two, faced public opposition, yet now are widely used. Nuclear power, on the other hand, is an intangible used only indirectly by consumers and looks the same regardless of its source. Thus, the specific attractions that brought public acceptance to so many earlier technologies are missing in nuclear power.

Today the debate over nuclear power is in a most confused state. What originally were concerns about environmental threats have been subsumed in a

broader and highly polarized debate over social issues. The one feature shared by most debators is intolerance. Opponents and proponents generally state their positions well, but listen too much to themselves and not enough to opposing viewpoints. Each participant rejoices to make a hole in the other person's part of the boat.

To make matters worse, interest groups on both sides selectively ignore certain aspects of the nuclear power question and use technical and environmental issues less as educational tools to stimulate discussion than as weapons to accomplish their hidden social objectives. Proponents of nuclear power tend to dismiss the problems inherent in waste disposal, large-scale energy production, and unlimited growth. Opponents tend to do very shallow comparative assessments of energy sources and overestimate the contribution alternative energy sources can make in this century. Many opponents sensationalize the failure to solve the waste disposal problem, yet criticize all proposed solutions in order purposely to impede progress and thereby speed the demise of the nuclear option.

□ *Capital Scarcity.* A third source of anxiety among the electric utilities is the difficulty of securing the large-scale financing needed to construct nuclear power plants. This problem has two origins: the general unwillingness of banks to finance long-term, capital-intensive projects during inflationary periods, and the unpredictability of costs and returns on investment involved in building nuclear plants. Little can be done about capital scarcity caused by periods of sustained inflation but unpredictable construction costs stem from the two sources of uncertainty previously mentioned. Amelioration of the social and institutional problems facing the nuclear option would therefore do much to reduce uncertainty and make long-term capital markets more accessible to the builders of nuclear plants.

Now, all of the aforementioned sources of uncertainty aggravate one another. Social opposition to nuclear power makes intervention through the courts more likely, thereby increasing the probability of construction delays and unpredictable escalations in cost. Regulatory changes become more likely and also more unpredictable, thus preventing the utilities from anticipating the nature of those changes. In consequence of all this, rates of return on investment cannot be anticipated and utilities find it difficult to secure financing for the construction of nuclear units. Meanwhile, the public, lacking an authoritative source of information concerning potential dangers, is easily swayed by anti-nuclear arguments. Social opposition increases, and this self-amplifying spiral of mounting uncertainty brings the nuclear industry ever closer to collapse.

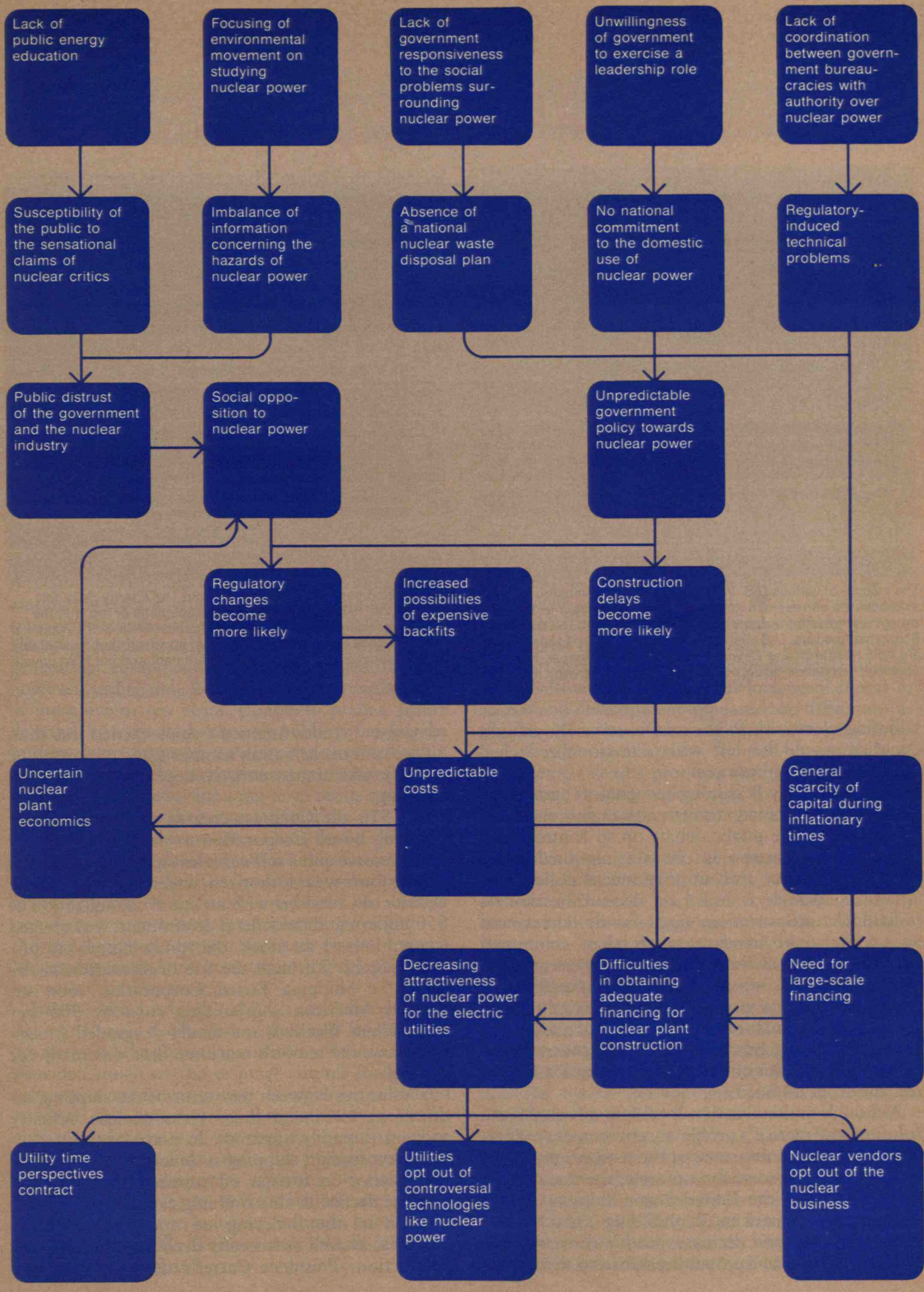
Effects of Uncertainty: The Avoidance of Controversial Technologies

Forty-year equipment lifetimes, slow staff turnover, and continued similarity of product have made the utility industry conservative. Since utilities get their rewards not from building any one type of plant, but rather from providing electricity to their customers, they delay new construction in the hope that dwindling energy supplies will create a public consensus on what types of facilities ought to be built.

Nuclear power, the most controversial of the energy-generating technologies, is given up first. Indeed, the principal nuclear vendors may opt out of the nuclear business even earlier than the utilities — perhaps by 1985. None of the vendors has more than 25 per cent of its business in nuclear power, and unless uncertainty is reduced enough to spur new plant orders, the majority will likely drop out. Recovery would prove difficult. The vendors, having built up a considerable industrial infrastructure yet in vain, would surely demand assurances of government financial and policy support before reentering the market. The continuing controversial nature of nuclear power would likely make such assurances impossible.

If the current trend continues, and we see no changes in prospect, only the federal government may remain willing and able to build new nuclear plants. The result would be a *de facto* nationalization of the nuclear generating business. But this is not all. As more becomes publicly known concerning the hazards inherent in other energy sources — coal, for instance — they, too, are likely to become highly controversial. The subsequent proliferation of uncertainty might well cause the utilities to opt out of constructing *any* new generating facilities and concentrate instead on the less risky business of dis-

The societal factors that bedevil the U.S. nuclear option are shown in schematic diagram. Three important consequences appear at the bottom of the chart: First, nuclear vendors — the manufacturers of power reactors — opt out of the business; second, the electric utilities abandon nuclear and other controversial technologies; and third, the utilities cease to concern themselves with the risky business of trying to anticipate the energy needs of the coming decades.


Lack of public energy education
Focusing of environmental movement on studying nuclear power
Lack of government responsiveness to the social problems surrounding nuclear power
Unwillingness of government to exercise a leadership role
Lack of coordination between government bureaucracies with authority over nuclear power
Susceptibility of the public to the sensational claims of nuclear critics
Imbalance of information concerning the hazards of nuclear power
Absence of a national nuclear waste disposal plan
No national commitment to the domestic use of nuclear power
Regulatory-induced technical problems
Public distrust of the government and the nuclear industry
Social opposition to nuclear power
Unpredictable government policy towards nuclear power
Regulatory changes become more likely
Increased possibilities of expensive backfits
Construction delays become more likely
Uncertain nuclear plant economics
Unpredictable costs
General scarcity of capital during inflationary times
Decreasing attractiveness of nuclear power for the electric utilities
Difficulties in obtaining adequate financing for nuclear plant construction
Need for large-scale financing
Utility time perspectives contract
Utilities opt out of controversial technologies like nuclear power
Nuclear vendors opt out of the nuclear business

Industry	Income (Millions of dollars)	R&D Expenditures (Millions of dollars)	Per cent of income
Chemicals and allied products	23,843	2,410	10.1
Instruments	8,889	854	9.6
Machinery	36,857	2,286	6.2
Motor vehicles and transportation equipment	34,708	2,003	5.8
Electrical equipment and communications	53,551	3,016	5.6
Primary metals	24,523	356	1.5
Fabricated metal products	24,324	296	1.2
Food and kindred products	29,511	323	1.1
Projected 1979 U.S. fuel bill and expenditures on energy R&D	180,000	4,100 (3,300 government, 800 private)	2.3

The income of various U.S. industrial sectors is compared to their expenditures on research and development. The year is 1975, except as indicated. Income figures are taken from the Bureau of Economic Analysis, U.S. Department of Commerce. Expenditures are from *Research and Development in Industry Annual,* National Science Foundation, except for expenditures on energy research and development, which are taken from *The Energy Daily* for January 24, 1978. Considered as a percentage of income, the funding for energy research and development falls in the middle of the other sectors' investments. Notice, however, that most of that funding derives from the federal government and not from private industry.

tributing electricity to their customers. By default, America would be left with a nationalized electricity-generating business.

This possibility is gaining recognition among the nation's energy policy makers, although none seems willing to initiate public debate on so controversial an issue. The reason is obvious: nationalization would be a major shift in government policy. The American lifestyle is based on decentralization — individual transportation, single-family homes, and so on. Personal freedom rather than communal cooperation lies at the heart of the American *Weltanshauung*. To most Americans nationalization means inefficiency, organizational inflexibility, and lowered individual incentives. The increasing resentment of "big business" and "big government" have reinforced this almost innate opposition to centralization of authority.

Although nationalization is seldom advanced as a solution to America's problems, government ownership has helped solve some of the nation's problems in the past. Consider, for example, the creation by the Congress of the United States Shipping Board Corporation. American shipbuilding capacity had peaked in 1860 and declined steadily thereafter. By 1916, when war in Europe threatened to disrupt international trade, America's ships carried less than 10 per cent of the nation's imports and exports. The country was almost entirely dependent on foreign shipping.

In 1916 the Congress created the United States Shipping Board Corporation to develop a national naval reserve and a self-sufficient maritime fleet. The corporation was authorized under the laws of the District of Columbia with an initial capitalization of $50 million and the federal government was obliged to own half of the stock, the rest being sold to private citizens. Through the use of standardized designs the Shipping Board Corporation soon increased American shipbuilding capacity 300 per cent. When World War I finally demanded American entry, the nation's maritime fleet was ready for the task.

Similarities between the status of the shipping industry in 1916 and that of the nuclear industry today are readily apparent. In place of the dependence on foreign shipping is America's present-day dependence on foreign oil supplies. In place of a 60-year decline in ship building capacity is a drastic decline in the ordering of nuclear generating facilities, as well as a steady decline in domestic oil production. President Carter's description of im-

pending energy shortages as the moral equivalent of war is in itself suggestive of the establishment of a federal corporation to own and operate future nuclear power plants, although the context of the President's statement does not suggest that he had this in mind at the time.

We do not believe that nationalization is the optimal path for the United States to follow with regard to its ailing nuclear industry. But if measures are not taken to reduce uncertainty surrounding the nuclear option, the government may remain the only sector with sufficient resources to construct new generating facilities. It is important that public debate on this subject begin, if only to prepare the public for what may be an unavoidable shift toward greater government ownership.

Effects of Uncertainty: Shortened Time Perspectives

A second, less obvious effect of excessive uncertainty among the electric utilities is the shortening of their time perspectives. Utilities have traditionally looked ahead several decades to anticipate when new generating equipment would be needed. Today, however, utility time horizons have been reduced to at most five or ten years. Unable to predict future demand, construction costs, or public attitudes, the utilities focus more on meeting short-term fluctuations in demand, by buying diesel generators for instance, than on assessing long-term needs and planning how to meet them most efficiently.

Shortened time perspectives have had a debilitating effect on the development of alternative energy options as well. Utilities have long relied on the manufacturers of electrical equipment to conduct necessary research and development, paying for it through higher equipment purchase prices. This arrangement exists not because of logical planning, but rather by happenstance.

Briefly, the history is this. It was through the Atomic Energy Commission that the federal government and the Joint Committee on Atomic Energy provided much of the original stimuli for the development of nuclear power. The private sector did conduct the majority of development work on civilian nuclear power, but this was mainly because optimistic demand and fuel cost projections made the potential rewards very attractive. In the 1960s and 1970s increased environmental awarenesss brought about more stringent pollution control and accident prevention requirements which decreased private sector interest.

Year	Total operating revenue ($ millions)	R&D expenditure ($ millions)	R&D (percent of total operating revenue)
1973	23,510	649.2	2.76
1974	26,150	699.1	2.67
1975	28,930	760.7	2.63
1976	32,790	823.3	2.51
1977	36,440	891.8	2.45

The income of American Telephone and Telegraph Company is compared to its expenditures on research and development. The research and development fraction is similar to that for energy research and development — over 2 per cent — but in the case of the communications network the funding of research and development is entirely by the private sector.

As research and development grew increasingly complex, its cost became uncomfortably large for any single vendor to take on. With demand projections falling, and since the results of long-term research and development are rarely captured by the sponsoring firm alone, but are reaped by their competitors as well, the market for long-term energy research and development appeared too diffuse to justify the allocation of scarce private sector resources. Equipment manufacturers focused increasingly on developing saleable products through incrementally improving existing technology. By default, the task of developing long-term options fell to the government.

This dropping out by the private sector led to a schizophrenic energy research and development structure. There is very little communication between the users of energy options — the utilities and the public — and the developers of those options — the federal government and the national laboratories. While the latter share the responsibility for developing new energy sources, they have little input concerning the needs, desires, and experiences of the option users. As such, the industrial sector reacts mainly to the problems currently facing the utilities and the option development process becomes increasingly disconnected.

The users of energy options, conversely, are not involved in the development process and lack any incentive to address long-term problems such as what sort of energy future is desirable or how it might be achieved. The schism between option users and developers reinforces the shortening of time perspectives and all involved spend less time consid-

ering the broader social issues surrounding nuclear power.

When nuclear opponents raise broad social criticisms of nuclear power, the utilities find themselves unprepared to reply and fall on the defensive. Their responses do not lend themselves to the sensational media coverage that nuclear critics get. Indeed, the utilities often appear to have nothing to say in defense of nuclear power and public opposition grows. Long-term problems appear even less soluble to the public, faith in technology declines, opposition to nuclear power increases, uncertainty mounts, time perspectives contract, and another feedback loop is complete.

Year	Kw/hrs. sold by electric utiltites to ultimate customers (trillions)	Average revenue per Kw/hr. sold (cents)	Total revenue from ultimate customers ($ billions)
1974	1.701	2.30	39.1
1975	1.733	2.70	46.9
1976	1.850	2.89	53.5
1977	1.951	3.21	62.6

Sales and revenues for the electric utility industry. Data for 1974 and 1975 are from the Federal Power Commission; those for 1976 and 1977 are from the U.S. Energy Information Administration. In 1977 a 2-per-cent surcharge for electricity would have yielded $1.25 billion for research and development.

Options for Reducing Uncertainty

We have seen that the nuclear option faces debilitating social and institutional problems. No number of technical solutions alone can save it. This means that quick solutions will not be forthcoming. Instead, a multi-level approach should be pursued in order to keep the nuclear industry alive in the short term while a concerted effort is made to solve the longer-term problems.

To increase nuclear plant orders in the short term, the government must reduce uncertainty. First, the philosophy underlying the nuclear regulatory process should be more clearly articulated so that utilities can better predict how the rules are likely to change. Second, the government should announce a comprehensive national waste-disposal plan, including time and price schedules, which the utilities could use to estimate future waste-disposal costs. Third, the government should affirm the acceptability of domestic nuclear power and discuss its risks and benefits in a comparative context. Together these measures would increase utility confidence and partially restore health to the nuclear industry.

The decentralized structure of American government does not lend itself to such a leadership role. Indeed, the federal government was purposely designed to be weak in terms of imposing decisions from above (as compared to a parliamentary system), and all various independent regulatory actors on the state and federal levels resist integration under a single, clearly-defined regulatory philosophy. Moreover, the virtually unlimited opportunities which exist to intervene and overturn prior ruling prevent any decisions that *are* made from serving as dependable indicators of future policy. Issues cycle throughout the system without resolution, and indecision is transferred to even higher administrative levels. Eventually, a level is reached where the opposing positions must be reconciled, but the burden of decision all too often falls on an inadequately prepared and overworked government official who must act hastily. From a societal perspective, this decisionmaking process is neither efficient nor reassuring.

Increasing government direction can only partially reduce uncertainty. Affirming the acceptability of nuclear power and clarifying nuclear regulatory policy will do little to reduce public opposition. The aforementioned strategies are, therefore, only stopgap measures aimed at restoring enough health to the nuclear option to keep it alive while more comprehensive, longer-term solutions are pursued. We have two such solutions in mind:

☐ *Rearranging the research and development structure of the utility sector.* The United States currently invests about 2.3 per cent of annual energy sales in energy-related research and development. This corresponds to the average research and development expenditures of all capital-intensive industries and, at least as a starting point, seems a reasonable aggregate figure. (See the table on page 58.) American Telephone and Telegraph (A.T.&T.) annually devotes about 2.4 per cent of its annual revenues to research and development (see the table on page 59). Doing so has kept it at the forefront of communications technology without needing government support.

What worries us is the distribution of national energy research and development sponsorship. The electricity-generating sector is capital-intensive,

regulated, and long-lasting like A.T.&T., yet it plays only a minor role in sponsoring energy research and development. In fiscal year 1979, for example, the federal government contributed $1,708 million to energy research and development. The utilities, mostly through the Electric Power Research Institute (E.P.R.I.), sponsored only about $200 million.

The annual contribution by the utilities to E.P.R.I. is an admirable sum, considering that it is voluntary. Most of the research and development conducted by E.P.R.I., however, is oriented towards producing short-term improvement for early industrial application — a reflection of the attitude of its utility-dominated governing board. In point of fact, E.P.R.I. was founded in response to a 1971 Senate insistence that the utility industry address environmental, technological, and other social problems and only after Congress threatened to require the utilities to contribute a far greater sum to a centralized research and development coordinating body. For all of these reasons, E.P.R.I. is presently an unsatisfactory precedent for conducting long-term energy research and development on a national level.

What distinguishes the electric utility sector from A.T.&T. is that the latter has succeeded in pursuading its regulators that research and development are necessary to ensure continued technological progress and reliable service. A.T.&T. is allowed to include a charge for research and development in the price of telephone service so that its customers benefit from technological improvements in direct proportions to the amount of service they use.

If the electric utilities were permitted to operate a similar system, they could greatly increase their sponsorship of energy research and development. In 1977, for example, the electric utilities sold nearly 2 billion kilowatt-hours of electricity at an average price to the ultimate consumer of 3.21 cents for each (see the table on page 60). If the utilities had charged 2 per cent more per kilowatthour (.0642 cents), over $1.25 billion would have been raised for contribution to a central research and development fund without the utilities incurring additional burden. As energy demand increases, thereby speeding the rate at which fossil fuel reserves are depleted, the level of funding available for research and development aimed at finding replacement sources would also increase. Moreover, the largest users of electricity would justifiably be contributing the most to developing energy sources for future generations.

A consortium of representatives from industry, government, utilities, and the public could be assembled to discuss long-term energy needs and develop research and development strategies. The funds raised by the utilities, along with those contributed by the government, would be channelled into a central fund which the consortium would use to sponsor work by private sector research organizations, universities, and national laboratories. Feedback from the research organizations would enable the consortium to revise long-term energy use and development plans and to adjust consumption patterns gradually rather than abruptly. Utilities would be closely coupled to the research and development process, time perspectives would be expanded, social issues would be addressed, and the allocation of research and development funds would more accurately reflect a consensus of national energy needs and development priorities.

Although the federal government would be able to reduce its sponsorship of energy research and development, it would also have to relinquish unilateral control over the expenditure of the funds it did contribute to the consortium. Such an arrangement would be unusual but there have been precedents. Since 1965, for example, the federal government has contributed nearly $4 billion to the Appalachian Regional Commission (A.R.C.) while exercising only partial control over how that money is spent. A single allocation is made to each A.R.C. state which then determines its own funding priorities.

☐ *Improving public understanding of energy issues.* The necessity of public understanding of vital issues has long been stressed. Thomas Jefferson argued that a well-informed electorate was both necessary and sufficient to avoid many ideological pitfalls. It is hard to imagine, given the disheveled nature of the current energy debate, that the energy problems in general or public opposition to nuclear power in particular can be resolved without first improving public understanding of energy issues.

Two factors inhibit such a government role. First, there is the well known reluctance of the federal government and private industry to address difficult social issues. On March 18, 1974, Claude Brinegar, then Secretary of Transportation, was confronted at a public forum in the House of Representatives Cannon Office Building with the argument that automobile size, efficiency, etc., should be more effectively controlled in the interest of the quality of urban life. He replied that the Administration's policy was not to interfere with public choice. That reply exemplifies a mistaken yet oft-made assump-

tion of the federal government. Any policy, even one of laissez-faire, represents a government decision on public choice. A laissez-faire approach does not, therefore, absolve the government of responsibility for the negative consequences that result.

Second, the federal government has traditionally avoided public education outside the classroom for fear of propagandizing. In the Department of Energy's fiscal year 1979 budget, for example, $63 million is allocated to energy information but 95 per cent of this goes for internal reports and analyses.

The government's neglect of public energy education has created an intellectual vacuum into which innumerable special interest groups have rushed, each expounding its own version of the facts and pressing for a specific future. They berate the assessments of competing groups and portray futures in which only their options appear credible. With no authoritative source of information to which to turn, the public is left to learn the facts of energy "in the gutter." Having left most of the complex social and technical intercomparison of energy options to be sorted out by the public as best it can, the federal government must bear a substantial share of the blame for the misunderstandings, unwarranted fears, and distrust which now exist.

Clearly the federal and state governments should concentrate on achieving maximum understanding. Indeed, history offers outstanding examples of how government involvement in public education solved pressing social problems and improved the quality of life. Consider the land-grant college system, certainly the most successful 19th century example of government involvement in public education. Via state and county cooperation, the land-grant colleges brought greater understanding of agricultural problems, rapid advances in agriculture, and an American agricultural preeminance which continues today. The very act of establishing agricultural and mechanical colleges emphasized the importance of those arts and ensured that the federal and state governments would influence the curriculum.

Public acceptance of nuclear power, and of energy conservation as well, depends critically on public trust in, and understanding of the energy decisionmaking process. As the legitimate representative of the public interest, the government should begin helping the public to understand the difficult choices which lie ahead. The process must necessarily be long-term and, carried out at all age levels, it must aim at raising public awareness of the social, economic, and environmental tradeoffs inherent in different energy options. Only in the light of comparative assessment can a rational energy debate arise.

Unpleasant choices will be necessary as America tries to manage its impending energy shortages. These difficult choices cannot be decided *for* the American people because discontent and distrust would inevitably result. Instead, the public should be involved in helping determine what energy options ought to be pursued. An educated public could make valuable contributions to the decisionmaking process and public confidence in that process would gradually increase.

Conclusion

Among the most serious problems facing the nuclear option in the United States are those of social and institutional origin; short-term measures may sufficently reduce uncertainty to keep the nuclear industry alive, but they alone cannot restore full health to the nuclear option. Time perspectives need to be expanded to prepare for the long term and the public must better understand the complexities of energy issues if the debate on nuclear and alternative energy sources is to assume a more rational course.

Common to each of the policy options outlined in this article is the need for the government to adopt what hitherto it has been unwilling to adopt — a leadership role. If the government delays legislative actions until energy shortages become so acute that they force the emergence of a public consensus on the need to act, the extremely long lead times needed to develop and construct new generating facilities will ensure that economic stagnation sets in before new energy sources can be brought on-line.

Recent delays in gaining public acceptance of even minor adjustments in national energy policy suggest that such discussions should have started much earlier. Despite these warnings, attention remains focused on the short term. With time growing ever shorter, we should begin to act together to keep our options open.

Timothy L. Montgomery will receive his A.B. from Harvard College in June, 1979. He is a government major specializing in the study of international relations, especially as pertain to the Middle East. He joined M.I.T.'s Light Water Reactor Strategy Assessment Group in June, 1977, as a sponsored research staff member of the M.I.T. Energy Laboratory. **David J. Rose** received his B.A.Sc. from the University of British Columbia and his Ph.D., in physics, from M.I.T. After work at Bell Telephone Laboratories he returned to M.I.T. in 1958, and has been Professor of Nuclear Engineering since 1960. From 1969 to 1971, however, he took a leave of absence to serve as Director of Long-Range Planning at Oak Ridge National Laboratory.

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This collection, prepared under the supervision of the editors of TECHNOLOGY REVIEW, includes such articles as "Generating Effective Corporate Innovation" by Edward B. Roberts, "Users as Innovators" by Eric von Hippel, "Innovation: The Fruit of Success" by Robert N. Noyce, and "Are You Ready to Become an Inventor?" by Louis Soltanoff. (All the articles in the collection originally appeared in issues of TECHNOLOGY REVIEW magazine from October/November 1977 through June/July 1978.)

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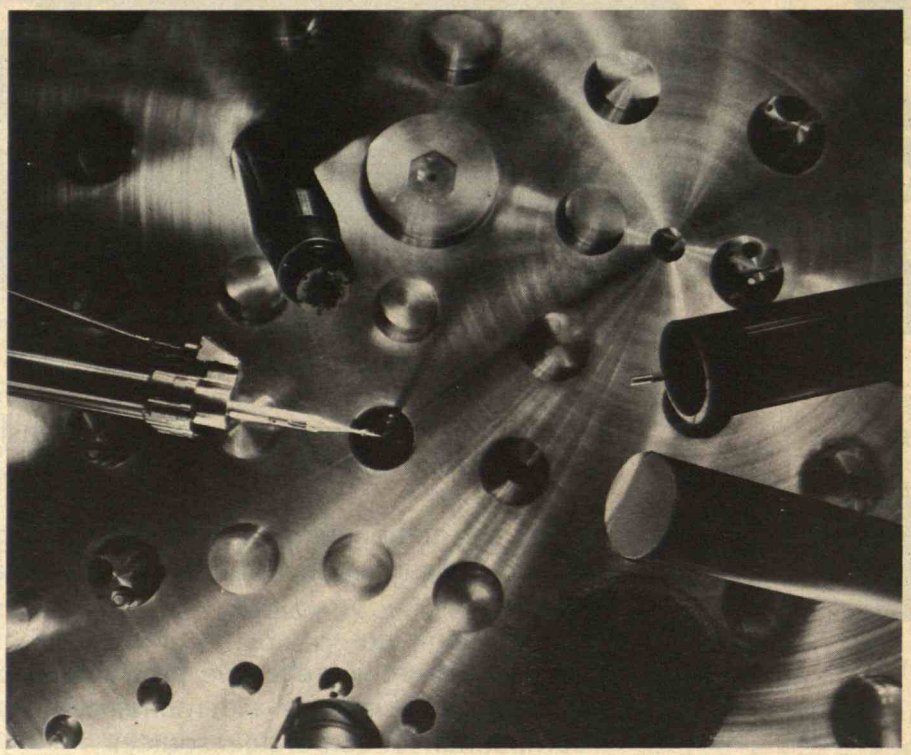
Trend of Affairs



Inside the Shiva target chamber. Tiny fusion fuel pellets about the size of a grain of sand can be mounted on the tip of the needle-like target positioner, which protrudes from the left. Shiva's 30 trillion watts of optical power can then be precisely focused on the targets. (Photo: Lawrence Livermore Laboratory)

Energy

Shiva and the Politics of Laser Fusion

A machine called Shiva at the Lawrence Livermore Laboratory in California is the latest development in the U.S. pursuit of an elusive goal — the economic use of laser fusion to produce limitless energy for the world of tomorrow. But there are political as well as physical constraints athwart its road to success.

At a recent symposium at M.I.T., Edward Teller, Professor of Physics (Emeritus) at the University of California at Berkeley, provided a glimpse into the future of Shiva and laser fusion technology. Dr. Teller, now retired but still a consultant to Lawrence Livermore, qualified his descriptions as being necessarily curtailed because of security constraints. "The really interesting parts of the process are secret," he said, speculating that the climate of secrecy may have served more to impair progress by stultifying international cooperation than to enhance security. Unlike magnetic fusion research, in which "the U.S. and Russians are fully and effectively cooperating," he said, such openness is lacking in laser fusion work. "It is wrong," he stated. "We keep things secret that everybody knows; we thereby prevent full discussion, which could make work proceed faster and money be appropriated — or refused — in a more reasonable way. And the Russians are ahead of us in publication . . . we have difficulty in persuading them to be a little more discreet and secretive about the subject than they are." The symposium attendees laughed, and he added, "I did not tell you what I am talking about so I am not violating security." More laughter.

He described Shiva — the heart of the Lawrence Livermore fusion experiments — as a "very wonderful apparatus," with 20 "arms" of neodymium glass lasers capable of storing 10 kilojoules of energy and discharging it with precise aim in a nanosecond. "It works," Dr. Teller said. "It has worked for some time." Shiva can produce 2×10^{10} neutrons per shot, some of which are "clearly thermonuclear neutrons." But to approach scientific breakeven, the device must produce 10^{15} neutrons. "And scientific breakeven is very

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modest compared to engineering breakeven, a modest aim compared to economic breakeven. A lot remains to be done," said Dr. Teller. Among the problems:

☐ Plasma blown off the deuterium-infused target by the initial impact of a laser "shot" reflects the remaining part of the laser burst.

☐ The neodymium laser array in Shiva "is not the best for the purpose," he said, because these lasers may shatter during repeated discharges at high power intensities. Furthermore, the relatively long wavelength of this laser tends to produce troublesome "runaway electrons" in the plasma, some of which penetrate and prematurely heat the target. Ideally, such heating must be delayed until compression from the orchestrated play of lasers is maximal, or the resulting explosion is smaller than it could be. Dr. Teller would much rather the wavelength were in "the ultraviolet range." To this end he offered a "concrete proposal": that a solution might emerge from further research to develop a means of speeding up the effective discharge of krypton-fluoride lasers, which have very large power capabilities — possibly as high as a megajoule — enough to penetrate the plasma and solve the reflection problem.

☐ An economic laser fusion machine would require, among other things, the ability to withstand a billion fusion explosions without fatigue, in a faintly radioactive surrounding. Even the strongest conventional materials are probably unequal to that containment challenge. Dr. Teller said a present idea to skirt this problem is to make a big enclosure, 10 meters across, filled with a ". . . lithium waterfall. The lithium will reproduce the tritium atoms that are burned up and will also shield the walls from the destructive 14-million-volt neutrons."

Then a humorous, if revealing, aside — researchers in magnetic fusion are probably closer to being "experts" than are those in laser fusion, said Dr. Teller, according to Niels Bohr's definition, which he paraphrased: "An expert is a person, who by his own painful experience has found out all the mistakes that one can commit in a very narrow field. In magnetic fusion I claim we are approaching the state of expertise; in the case of laser fusion we still have the happy experience of all these future mistakes. . . ."

What of the timetable for perfecting a laser fusion device? Said Dr. Teller: "Laser fusion is one of the most exciting developments, but in relation to the energy crisis, I am a little less hopeful than many people." — *L.A.P.* ☐

Nuclear Power Contrasted: France vs. the U.S.

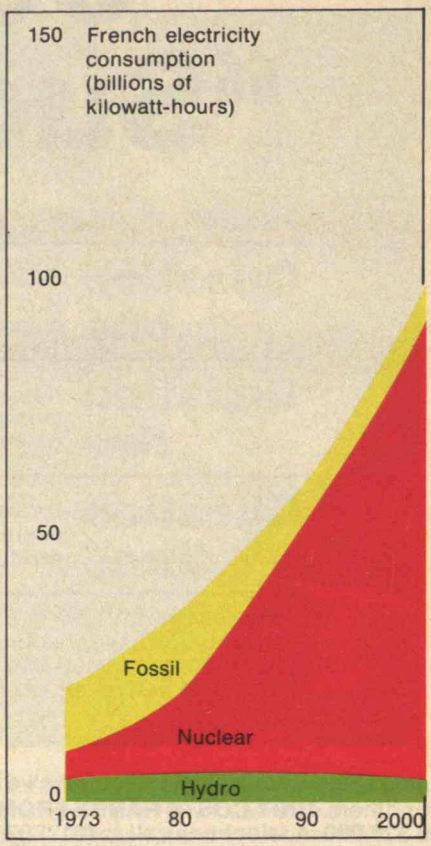
There is no parallel in the French experience for the costly and frustrating delays that now confound U.S. utilities seeking to locate and build nuclear power plants. Why this sharp contrast in the way a new technology is embraced and controlled by the two nations?

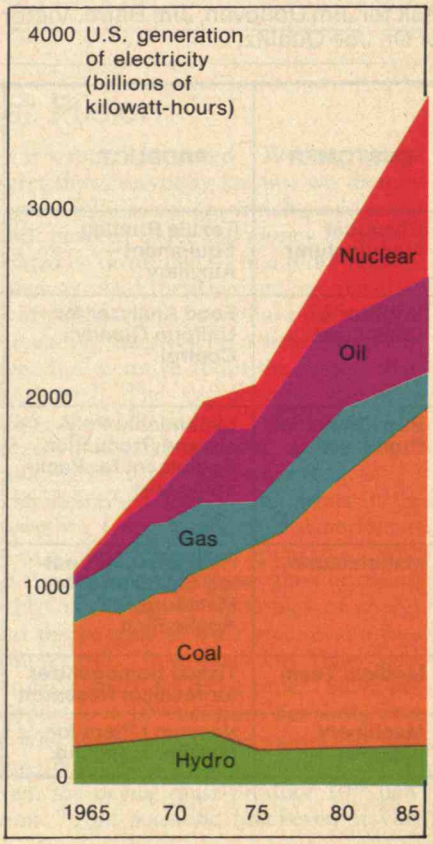
Three members of the M.I.T. Department of Nuclear Engineering and the M.I.T. Energy Laboratory answered this question after research for the Department of Energy. They concluded that the difference is fundamental, lying in the different ways electric power and indeed economic planning and growth are managed in the two countries and ultimately in their different philosophies and traditions of government.

One specific difference between French and U.S. regulatory systems is given special attention by Professor Michael W. Golay and his associates, Isi I. Saragossi and Jean-Mark Willefert. The French system exists in the context of a "national electric economy planned and controlled by the national government," they say. Decisions about the amount of capacity to be built and the fuel resources to be utilized are made by the government according to a prescribed national goal. Thus the issues of growth and strategies for achieving it are dealt with in the political process. As a result, "the economic justification for a power station is an accomplished fact" in France before site planning and environmental issues are even raised.

In sharp contrast, government agencies in the United State set and uphold environmental quality standards and are directly responsible for maintaining public safety. Economic growth in the United States is an indirect government responsibility, subject to both political and legal initiatives. In this context, licensing nuclear plants in the United States involves a mix of both technical and political issues. While the public may gain familiarity with the nontechnical, political issues involved, technical issues are likely to remain beyond the nonscientist's grasp. No one has responsibility for "balancing economic priorities against those of safety and the environment," say Professor Golay and his colleagues, and "there is no obvious way to deal with these disparate values in a consistent and predictable fashion, or even so that they can be weighed in free market terms."

The charts show how Michael W. Golay and his associates in M.I.T's Nuclear Engineering Department foresee the changes in the fuels France and the U.S. will use to generate electricity. France will rely increasingly on nuclear power, diminishing her dependence on fossil-fueled electrical generation. The U.S. plans to add increasing numbers of nuclear and coal-fired generating plants.





The contrast between the two nations' licensing procedures is consistent with what Professor Golay and his colleagues think are "fundamental differences" between the governmental traditions of France and the United States, the French system being an outgrowth of Napoleonic autocracy, the American an outgrowth of anticolonial revolution. No amount of research will lead to U.S. emulation of the French system, they say, despite the "heavy economic price ... of pursuing nuclear regulation in the American way." — *J.M.* □

Technology for the Arctic Oil Rush

For eight months of the year — November through June — the Arctic ice is empty and dark — a colorless winter wilderness made uninhabitable by wind, ice, and cold. But our ever-growing thirst for oil may soon change that. If drill ships now operating on the Beaufort Sea in the short summer season find the 320 trillion cubic feet of gas and 40 billion barrels of oil thought to be beneath that cold water, there will be irresistable incentive for men and machines to stay and work through the long winter night.

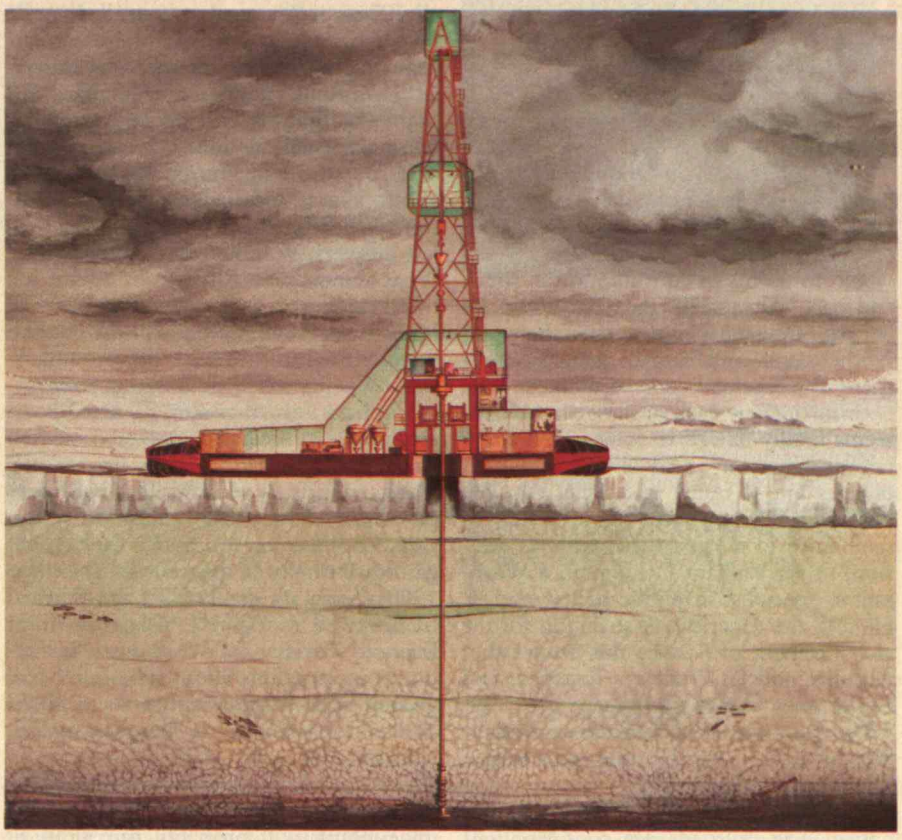
Innovative technology is ready. To bring drill rigs and their operators to the new sites, Russell B. Thornburg, Vice President of Global Marine Development, Inc., is promoting a line of air-supported vehicles. The largest is a 3,000–ton "barge," two-thirds the size of a football field, which could hover high enough above ice or tundra for Wilt Chamberlain to walk underneath. Two such barges — one carrying a drill rig, the other supplies — would together constitute a self-propelled air-cushion drill system bearing 2,400 tons of machinery and supplies and would move from site to site by winching themselves along lines secured to anchors.

Other air-support vehicles described by Mr. Thornburg for the American Association for the Advancement of Science early this year include self-propelled barges (support vehicles) of perhaps 250 tons' capacity, self-propelled tankers to carry perhaps 10,000 barrels of oil, and air-cushion lighters to move freight between conventional ships and shore during the short summer season. Mr. Thornburg is convinced that air-cushion vehicles are "the most efficient, cost-effective, and safest way to move and operate drill rigs in the Canadian archipelago."

The favored propulsion system — other than on-board winches — is a combination of wheels and paddle wheels bearing only enough of the vehicle's weight to assure traction, the rest of the weight being carried by the cushion of air; the "footprint" pressures of these propellers might be 100 grams per square centimeter — about one-tenth that of a conventional tracked vehicle for use on tundra or ice. Speeds might average 10 miles an hour: "the navigation problems of air-cushion vehicles ... can be avoided merely by exercising a little patience," Mr. Thornburg explained.

With the drilling done, how will oil and gas be moved from field to refinery and consumer? Pipelines through this land of ice and tundra have little appeal to many Canadians, and D. E. Evans of the Canada Department of Transport forecasts a fleet of icebreaking tankers supported by new "Class 10" polar icebreakers. "Class 10" means 150,000 horsepower — enough to cruise at will through the thickest Arctic winter ice (the largest existing icebreakers are two Russian Class 7 — 75,000-horsepower — ships). One "Class 10" vessel powered by a conventional steam turbine would require 17,000 tons of fuel a month — more than its bunkers could hold. But even monthly refueling is impractical, Mr. Evans told the A.A.A.S., so the Department of Transport is proposing an on-board nuclear reactor to produce 90,000 horsepower, with a 60,000 horsepower gas turbine as "booster" for use when full power is needed. When the design of "Polar 10" was begun in 1977, the cost was estimated at $300 million — not including the special equipment required to build it; at present no Canadian shipbuilder has facilities large enough for "Polar 10," and none can form hull plating thick enough. But if the Canadians decide to go ahead, "Polar 10" could be ready by 1985.

If this sounds far-fetched, listen again to Mr. Thornburg, talking now of an air-cushion icebreaker. The effect of an air-cushion vehicle moving over water is to depress the water surface under the vehicle. If the vehicle, serving as an icebreaker, is made to advance from water toward an ice sheet, the water is forced away and the unsupported ice crumbles of its own weight. The concept has been tested by the Canadian Coast Guard, and Mr. Thornburg is ready to put air-cushion icebreakers on the Great Lakes to quickly make possible year-round navigation at a very modest investment. An air-cushion icebreaker is said to cost 5 per cent of the price of a conventional icebreaker and to use 95 per cent less fuel. — *J.M.* □



This 3,000–ton drill rig, a barge 220 feet by 170 feet, will move itself to the location for its exploratory hole and — when this is finished — will move on to the next site. A second similar barge will accompany it with supplies and accommodations for the crew. Both are air-cushion vehicles which lift themselves off the surface and slowly winch themselves over tundra, water or ice — an air-cushion drill system proposed by Russell B. Thornburg of Global Marine Development, Inc., to carry economically man's search for oil to the coldest, most inhospitable reaches of the Arctic Ocean.

Coal: The Ace-in-the-Hole That Isn't There

According to the national energy plan, coal is to assume the role of America's premier fuel in the 1980s.

Heavy reliance on abundant, clean-burning western coal is likely, and plans have been discussed to transport it by rail or by pipeline (as a slurry in either water or oil) to points of consumption in south and east. Alternately the coal could be burned at the mine or converted there to a synthetic gas and used to generate electricity for baseload consumption.

Unfortunately each of these alternatives seems fatally flawed to someone. Energy, transportation, and environmental policies are so much in conflict that the "coal-fired economy" has little resemblance to a "reasoned national decision," says William F. Lipman, a Washington specialist in public policy studies. He told the American Association for the Advancement of Science this winter that national policies "reflect a logistical and environmental myopia."

For example, transporting vast quantities of coal — on the order of a billion tons per year eventually — from west to east by rail is the currently favored alternative. The railroads are confident that the business of moving as much as 60 million tons of coal a year by 1985 assures them a prosperous future. But critics point out that to move so much coal would require over thirty 100-car unit trains a day, and to some communities in Colorado this prospect of two or three loaded and as many unloaded trains an hour is bad news. The pollution from autos idling at grade crossings added to that from diesel locomotives will violate air quality standards; over 140 railroad-highway grade separations — at $1 million each — will be needed by 1985, according to Jack Kinstlinger, Executive Director of the Colorado Department of Highways, whose budget is orders of magnitude inadequate to meet that need.

Most surveys say the railroads themselves can do the job. But Mr. Lipman and his colleague Aaron Gellman aren't sure. They think the railroads may need $7 billion to $10 billion of new capital to get ready, new technology — and the creative management to use it.

The railroads will also have to figure in managing the ash and sludge left over after coal is burned. A 1000-megawatt plant fired with Wyoming coal would generate about one acre-yard of sludge from its scrubbers daily and 200,000 tons of ash and 600,000 tons of fly ash annually. There is "better than a small chance" that these wastes will contain enough heavy metals and radon gas to be classed as "hazardous" under federal regulations, said Mr. Lipman, and no one seems to know what will be done with it.

If coal can't be moved by rail, what about slurry pipelines? That question seems to lead to many more — and to very few answers. Will there be enough water? What about the quality of water after it's taken the coal from Wyoming to the Midwest or South? How will the coal be dried after transporting? Or burning it wet? What effect will freezing temperatures have on the slurry? Could oil (perhaps synthetic oil) be used as the slurry liquid?

A similar array of difficulties confronts advocates of other coal-utilization strategies. A commercial process for on-site coal gasification may be possible by the "late 1980s," says Antarn P. Sikri and Edward L. Burkwell of the U.S. Department of Energy's Division of Fossil Fuel Extraction; but questions about subsidence and ground water contamination were raised by Professors Harold L. Bergman and G. Michael DeGraeve of the University of Wyoming. More conventional systems for converting coal to electricity at the mine-mouth will probably run afoul of Environmental Protection Administration standards for maintaining the existing high quality of air in mine areas, thinks Mr. Lipman, and they depend on new technologies — mostly untested — for transmitting high-voltage, direct current electricity.

Policy and technology together compound uncertainty and create what Mr. Lipman calls a "pervasive hesitancy" in industry and investors to look favorably at a future based on coal. What's needed, said Mr. Lipman, is "a level of analysis, a commitment to long-term planning and development, and a degree of intergovernmental collaboration that has yet to emerge — anywhere." — *J.M.* □

The Public Stake in Solar Technology

Does the government's proper business include subsidizing solar energy? It does indeed, says Michael D. Yokell, an economist at the Solar Energy Research Institute in Golden, Colorado.

Dr. Yokell gave three reasons supporting his contention to the American Association for the Advancement of Science early this year.

□ The benefits of solar energy use include the conservation of traditional fuels, thus extending benefits beyond the direct users of solar energy to society as a whole, both in the present and the future. That being the case, government support is warranted to absorb some of the risk inherent in developing solar technology and to stimulate its adoption.

□ Extensive use of solar energy would reduce indirect costs that the public experiences from other forms of energy — health costs of pollution, for example. About $1.5 billion in health-related social benefits would issue from a 10 per cent shift in energy demand from fossil to solar, according to Dr. Yokell's computations.

□ Government subsidies to other forms of energy — as much as $130 billion since 1918, according to Bruce Cone of Batelle Pacific Northwest Laboratories — have encouraged their overuse. Solar energy obviously has a lot of catching up to do.

Dr. Yokell suggests many different forms of government support: direct grants and tax credits to solar users to offset subsidies which now favor conventional fuels; low-interest loans and loan guarantees to reduce the burden of the large capital investment necessary for building solar systems; government warranties to reduce the risk to users of this relatively untested technology; government demonstration and procurement programs to reduce risk and unit cost by increasing the use of solar technology; government loans and tax advantages for solar manufacturers to reduce their costs; and appropriate government-sponsored solar research and training programs for manufacturers and installers.

Among these, the "major omission" from federal support, said Dr. Yokell, is "a mechanism to compensate for the substantial underpricing of conventional sources of energy." He suggests direct grants and tax credits to end users. Dr. Yokell also advocates a warranty program for solar equipment with the costs shared between government and manufacturer.

Clearly, writes Dr. Yokell, "the value of a given contribution from solar energy technologies will increase dramatically through time as conventional fuels become more scarce and expensive. But that does not justify in economic terms "the public clamor for solar energy now"; the real problem is "to devise and select a mix of subsidy programs to maximize social welfare," and that requires continuing review of energy supply and demand trends, and present and future technologies. — *J.M.* □

Astronautics

The Venus Invasion

History's most concentrated assault on the mysteries of a single planet began in December, 1978, when ten spacecraft of the U.S. and U.S.S.R. arrived at Venus. Ever since then an avalanche of data has been returning to Earth, submerging scientists in so many numbers that analysis is falling far behind.

Here are some of the early findings and their interpretations:

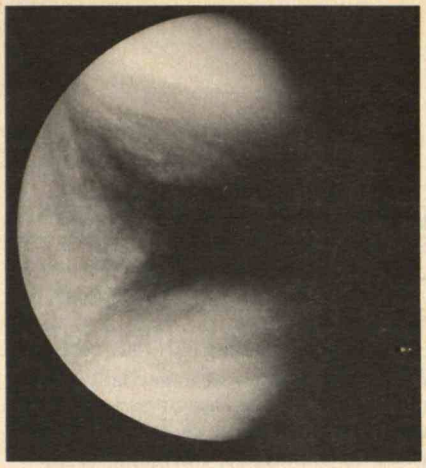
☐ Most planetary atmospheres include three kinds of constituents: the products of outgassing from the planet itself from vulcanism, geysers, and the like; gases produced inside the planet by radioactive decay — for example, argon-40 produced from the decay of radioactive potassium-40; and noble gases held in the planet's atmosphere ever since its creation. Earth's major outgassing products are water vapor (H_2O), carbon dioxide (CO_2), and nitrogen (N), with N the most abundant in the atmosphere because so much of the H_2O and CO_2 is bound up in Earth materials. The atmosphere of Venus turns out to contain about the same concentrations of CO_2 and N as Earth's, but mysteriously it seems to have far less water than it should if Venus were created from the same materials as Earth. The gases from radioactive decay are present in about the same amounts as on Earth. But the primordial noble gases are much more plentiful in Venusian air than in Earth's — another enigma. Explaining these observations may force fundamental changes in our view of planetary histories.

☐ Venus is the hottest planet in the solar system. Most of the heat is the result of "greenhouse effect" — postulated to be mostly the result of CO_2 in the Venusian atmosphere; but Pioneer-Venus reveals that water vapor and sulfur dioxide are also present to help hold the planet's heat. In addition, the constant cloud cover prevents some planetary heat from escaping into space.

☐ Venus has no magnetic field to deflect the solar wind, as has Earth. Thus charged particles from the sun actually reach Venus' ionosphere, and they probably account for the surprisingly high temperatures (5,000° K.) that Pioneer-Venus found in the Venusian ionosphere, but the mechanism for transforming solar wind energy into ionospheric heat is unclear.

☐ Fierce electrical phenomena have been detected in the atmosphere of Venus. The Pioneer-Venus orbiter may be picking up static from lightning on some of its passes over the night side of the planet. The Soviet Venera 11 and 12 landers measured up to 25 lightning strokes per second during descent, and their live microphones — the first ever carried to another planet — detected one 85-decibel sound of unknown origin. Electrical discharges in Venus' clouds are hard to understand: the clouds contain a good deal of sulphuric acid, which is highly conductive and should prevent local build-up of electric charges.

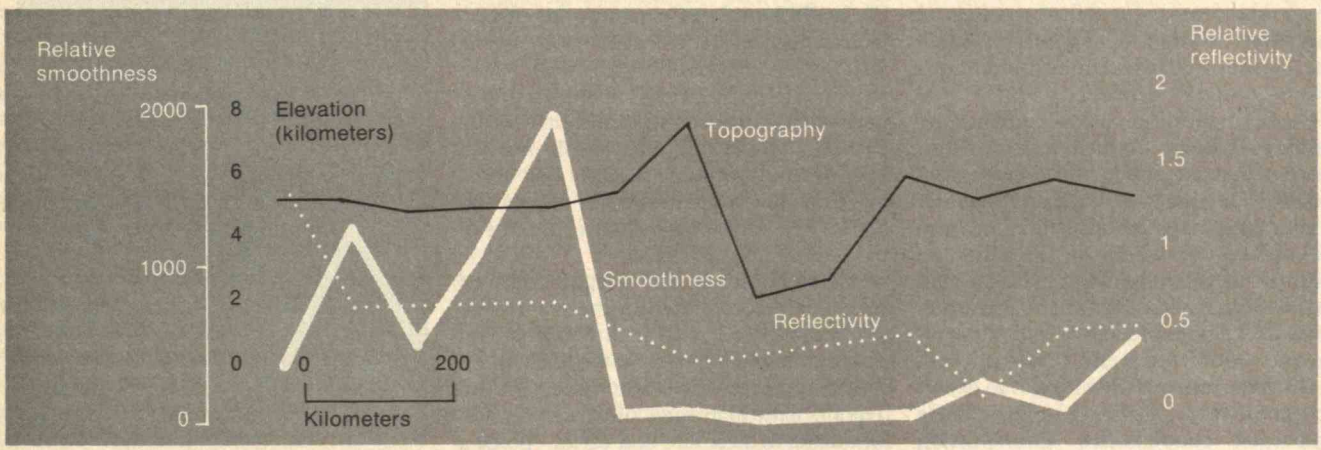
☐ First data from the Pioneer-Venus radar mapping experiment, on which Professor Gordon H. Pettengill of M.I.T. is principal investigator, show a huge valley a thousand miles long, 50 to 100 miles across, and several miles deep on the far side of the planet, invisible to Earth-based radar. Some 900 miles of the canyon have been mapped to date, and Professor Pettengill thinks the feature is much more extensive. It's hard to imagine an exogenous process — such as weathering or erosion — that could cause such a valley, and Professor Pettengill thinks it may be the result of crustal movements such as are associated with plate tectonics and sea-floor spreading on Earth.



The first Pioneer-Venus pictures, taken with the planet appearing as a crescent, showed virtually no markings. Later pictures, such as this, taken at closer to full phase, show detail in the ultraviolet — but none in visible wavelengths. Such markings may represent thin regions in the outer atmosphere through which the camera can see substances below that absorb ultraviolet light — perhaps sulfur crystals. (Photo: N.A.S.A.)

As this is written, results from two other M.I.T. experiments aboard Pioneer-Venus remain to be reported. Professor Irwin I. Shapiro is analyzing radio signals from the orbiter to learn details of Venus' gravity field, upper atmosphere, and rotation. And Professor Charles C. Counselman is analyzing radio signals to try to determine the speed and direction of winds throughout the depth of the Venusian atmosphere.

— *Jim Loudon* ☐



Parts of the surface of Venus are rugged, even mountainous, with elevations varying five kilometers in less than 100 kilometers of horizontal distance. Professor Gordon H. Pettengill of M.I.T., chief investigator for the radar experiments, calls attention to the correspondence between low values of smoothness and reflectivity with high local relief — which is a way of saying that where the terrain slopes steeply the surface is rougher.

Health

The Case of the Decaying Teeth: Filling in the Gaps

With all the drama of a partially solved mystery thriller, the case of cariology (the study of tooth decay) versus cavities has turned up numerous, intriguing clues — but no final indictment or judgment.

Sucrose sugar has been singled out as one of the arch villains. Dr. Ira L. Shannon, Director of the Oral Disease Research Laboratory of the Veteran's Administration Hospital in Houston, put it bluntly before the American Association for the Advancement of Science (A.A.A.S.) earlier this year: "Sugar causes tooth decay." In addition, rampant caries are *always* associated with sugar-rich diets, he said. The sugar found in between-meal snacks is particularly virulent because it tends to remain in the mouth for long periods of time.

Nevertheless, Americans can't seem to resist siren sugar, each of us ingesting an average of two and a half pounds weekly. Victims of tooth decay are plentiful: about 9 to 11 of the 28 teeth of 14-year-old New England residents have cavities, and perhaps one billion unfilled cavities exist nationwide.

Dr. Martin E. J. Curzon, Director of Cariology at the Eastman Dental Center in Rochester, New York, told the A.A.A.S. that the best strategy for reducing cavities in the U.S., given the national sweet tooth, is to "make teeth stronger." But accomplishing that worthwhile goal requires an understanding of the causes of decay, and ferreting out the facts is a job not unlike solving a vexing crime committed by unseen perpetrators with only circumstantial evidence for proof.

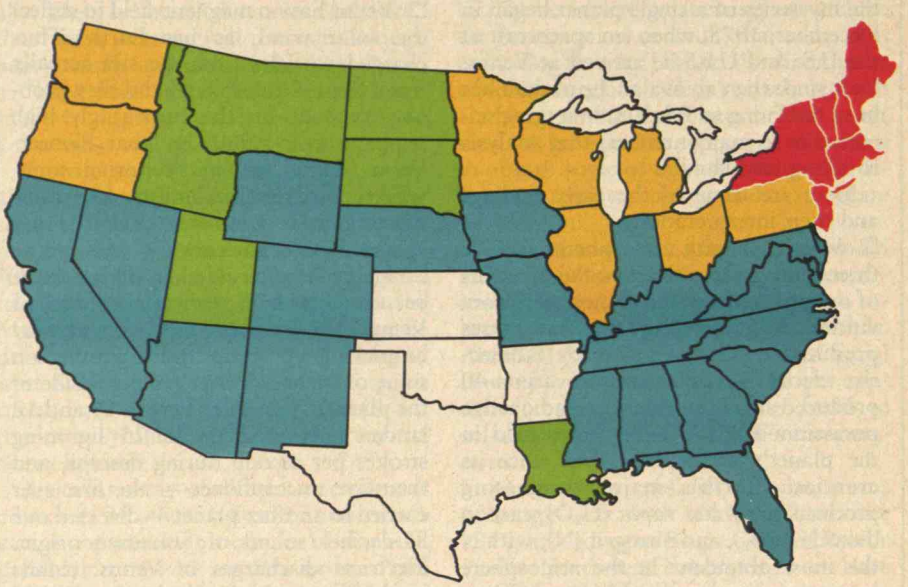
The best clues found by U.S. dental researchers so far are inconclusive. It is known, for example, that different regions of the U.S. are host to greatly varying rates of tooth decay. First investigations into this disparity pointed to the value of fluoride in preventing caries. But subsequent scrutiny showed that caries rates in similarly fluoridated areas vary up to 50 per cent. "Something else is acting," said Dr. Curzon, and it is only logical to examine other trace elements for similarly cariostatic propensities. Dr. Curzon brought the A.A.A.S. up to date on three:

☐ The New Zealand government in 1960 found that molybdenum had a definite role in producing decidedly different rates of caries between children in Napier, North Island, and children in nearby Hastings. Urinalysis of both groups of children showed elevated levels of molybdenum in the relatively caries-free Napier children. The source of the molybdenum: the well-gardened soil in the Napier region, elevated above sea level by an 1899 earthquake. The research then moved into the laboratories of the New Zealand Medical Research Council: molybdenum added to laboratory rats' high-sucrose — and cariogenic — diet produced a "definite indication that the molybdenum reduced dental caries," said Dr. Curzon. Human studies in Hungary and England also show that, statistically, "molybdenum was associated with low levels of dental decay." Currently, molybdenum is considered to be "mildly cariostatic," he said.

☐ A 1969 study of caries in the eastern U.S. suggested that regions with acidic soils are caries-prone and those with alkaline soils are caries-low. But local disparities in caries rates marred the overall pattern; no obvious relationship has yet been found among the pH of soils, molybdenum content of soils, and caries. For lack of additional evidence, the role of pH is presently undecided.

☐ A 1952 study in Oregon showed selenium (detected in the urine of subjects) to be associated with high incidences of caries. But later work showed selenium-*deficient* areas of the U.S. to be associated, overall, with high rates of caries. The relationship of selenium and caries "poses a bit of a paradox," concluded Dr. Curzon.

☐ Refreshingly conclusive results were generated by a recent U.S. Navy study, which identifies strontium as a cariostatic trace element. Out of 270,000 sailors surveyed, 360 were found to be caries-free



The regionalization of tooth decay in young adults 15 to 19 years old. Data refer to decayed, missing and filled teeth. (Statistics: Dr. M. E. J. Curzon)

Strongly cariostatic:	Fluorine Phosphorous
Mildly cariostatic:	Molybdenum Vanadium Strontium Boron Lithium
Cariogenic:	Selenium Magnesium Cadmium Copper Lead Silicon Manganese

The statistical connection between dental caries and various trace elements found in soil and drinking water looks like this, according to Dr. Martin E. J. Curzon of the Eastman Dental Center in Rochester, New York.

("rather an indictment of our society," said Dr. Curzon) and, curiously, 36 of the caries-free subjects came from one rural region of Ohio. Investigation showed the drinking water in the region to contain optimal amounts of fluoride (1.0 milligrams per liter). But the occurrence of caries-free life-long resident children corresponded with higher levels of strontium in the soil. Confirming studies with rats have indeed shown that strontium is an effective decay preventative and is even more effective when used in combination with dietetic fluorine.

However, before dissolving molybdenum and strontium in your fluoridated water, consider Dr. Curzon's important caveat: The results of correlation studies inevitably produce some apparent "positives, but whether these are "pure mathematical chance, or whether there is something substantial there, I'm not sure." — *L.A.P.* □

The Ubiquitousness of Organic Waste

Two years ago the United States Environmental Protection Agency (E.P.A.) determined a list of 129 "priority" pollutants (114 of them organics) about whose existence and control as effluents from industrial processes it wanted to know as much as possible as soon as possible. Two questions were paramount: how much of these pollutants are in fact being released, and what is the state of the art for their control? Answering these questions across a broad range of American industry turned out to be an enormous job, now about half done at a cost of $8 million. Indeed, it must be one of the largest tasks in trace material measurement ever undertaken, and a large part of the effort has gone into finding new technology for identification and measurement — a clear example of government regulation spawning, not stifling, technological innovation.

The results, beginning now to trickle in, show that organic waste is ubiquitous. After studying several industries — timber products, pesticides, gum and wood, organic chemicals, and printing and publishing — Environmental Science and Engineering, Inc., of Gainesville, Fla., has a list of 35 volatile organics used (and released) by almost everyone; these are chloroforms, benzenes, polynuclear aromatics, and phthalates widely used as industrial solvents. Forty-nine of E.P.A.'s "priority" compounds were not found at all. Effluent concentrations are generally very low. But it's too early to say how much improvement in the control of these compounds is within the state of the art.

Meanwhile, new problems have arisen:

□ The black plastic sheets which Florida farmers use to discourage weeds and warm the soil between rows of vegetables are responsible for new pollution in Everglades National Park, according to National Oceanic and Atmospheric Administration (N.O.A.A.) chemists. They are often burned at the end of the growing season, and winds carry PCBs in the smoke across the flats of southern Florida. Resulting PCB concentrations have thus far reached 22 parts per billion in one Everglades area.

□ By Eli Lilly and Co.'s own Admission, on the basis of effluent tests, about 1.5 parts per billion of nitrosamine are present in the treated effluent from its Lafayette, Ind., plant. The E.P.A. set the cancer risk due to Lilly's nitrosamines in the Wabash river at 1.2 in 10 million — meaning one case in 8,000 years in a city the size of Terre Haute, Ind. Five Lilly scientists take issue with E.P.A.'s assumption: after studies of photolysis processes in the Wabash River, they told the A.C.S. that nitrosamines are destroyed by sunlight and are "very unlikely to persist in the environment."

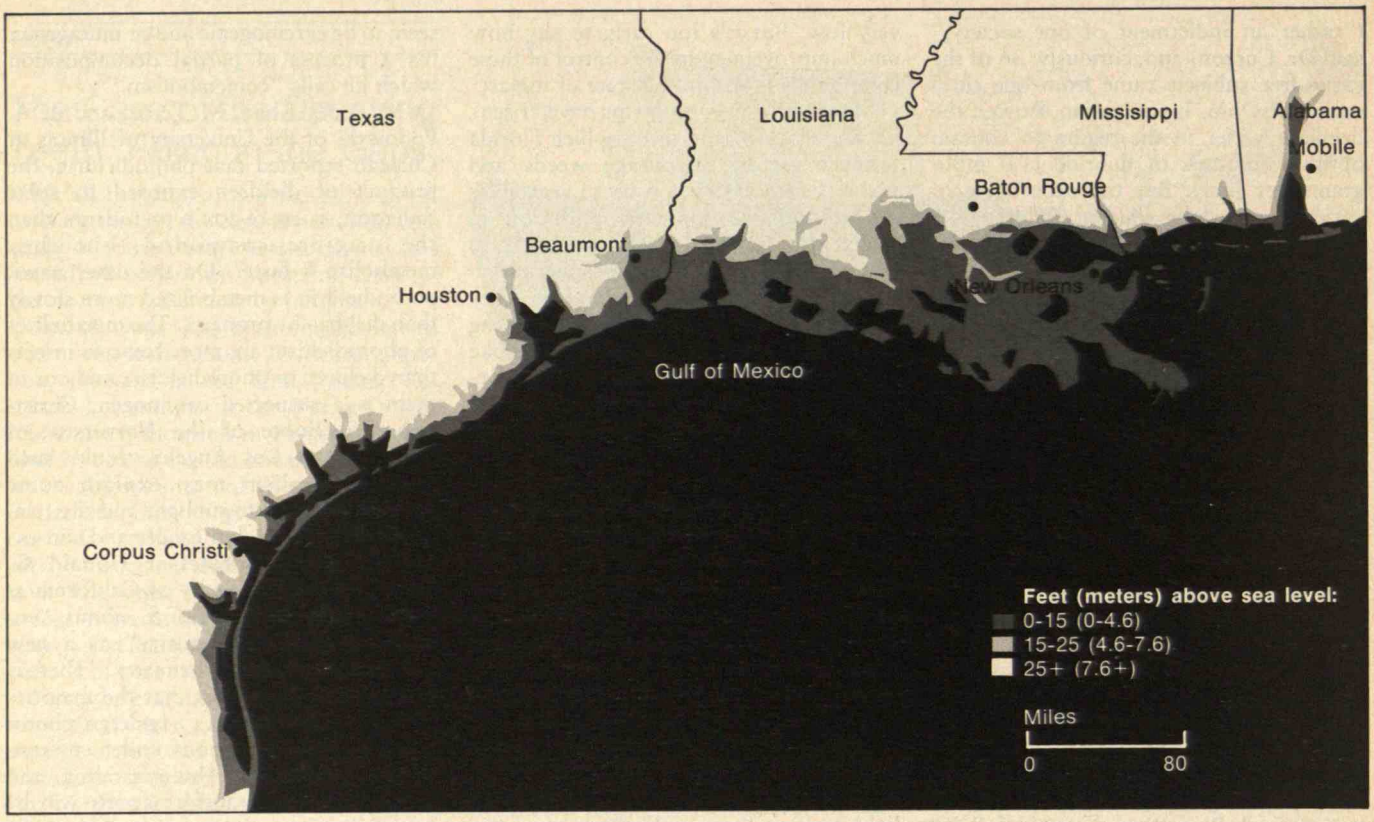
□ Good news: *Acinetobacter phosphadevorus*, a newly-discovered microorganism with a special craving for oil. Irving Yall and Charles F. Russ of the University of Arizona, its discoverers, can hardly wait to try out an armada of *Acinetobacter* on some small oil spill.

□ The U.S. pesticide/herbicide industry uses 900 different substances to make 60,000 registered formulations. Most of the latter are now "biodegradable," which means that the original formulations are short-lived in the environment. But that represents only the tip of an iceberg; the products of biodegradation have to be considered, too, and some of them are long-lived compounds whose biological activity is "largely unknown," says Professor M. T. Stephen Hsia of the University of Wisconsin. Professor Hsia cited the example of propanil, a herbicide whose ability to control grass in rice fields "dramatically increases" food yields. Two of its degradation products are potentially carcinogenic and may apparently be taken from the soil by plants later to be consumed by animals or man, and no one has yet really studied the matter. Professor Martin Alexander of Cornell University provided another example: the biodegradation of amines, which are themselves nontoxic, leads to a series of products that seem to be carcinogenic and/or mutagenic; it's a process of partial decomposition which he calls "cometabolism."

□ M. A. Q. Khan, M. Feroz, and A. A. Podowski of the University of Illinois at Chicago reported that photodieldrin, the product of dieldren exposed to solar radiation, is more toxic to rodents than the original compound, but they metabolize it faster. On the other hand, photodieldrin is metabolized more slowly than dieldrin by primates. The metabolites of photodieldrin are more toxic to insects than dieldren or photodieldrin, and one of them is a suspected carcinogen. Christopher S. Foote of the University of California at Los Angeles thinks such photometabolism may explain some people's allergies to sunlight and the relationship between skin cancer and sun exposure. Indeed, Professor Donald G. Crosby of the University of California at Davis spoke to the A.C.S. about "environmental photochemistry" as a new and emerging field of chemistry. "There is every reason to predict that the majority of 'toxic substances' . . . undergo photochemical transformations under environmental conditions. Understanding and measuring these transformations will be essential to hazard assessment," he said.

The rates of natural degradation are slow, the concentrations involved are very low, and apparent solution often lead merely to a new series of problems making studies in this area are very difficult — and scarce. Philip C. Kearny of the Department of Agriculture gave A.C.S. members his "want list": assay methods to reveal that degradation in fact is happening, research on degradation pathways and rates, and the identification of degradation products. Then for each identified degradation product there is exactly the same set of research needs all over again — an ever-lengthening chain of increasingly hard-to-answer questions, a vast new arena for analytical and organic chemists. Douglas M. Costle, Administrator of E.P.A., likened our knowledge of the health effects of the chemical revolution to "a block of Swiss cheese — full of holes." It's why there is now an acute shortage of toxicologists, said Eula Bingham, Assistant Secretary of the Occupational and Health Safety Administration. She herself, Dr. Bingham said, took a postdoctorate year in toxicology after being well started in a different field of chemistry, and she commended this route to others in her A.C.S. audience. — *J.M.* □

The "greenhouse effect" of increasing amounts of CO_2 in the atmosphere could cause a warming of world climate that would melt the great West Antarctic glacier. By early in the next century sea level could increase by 15 to as much as 25 feet; vast sections of the U.S. Gulf Coast would be flooded. Stephen H. Schneider of the National Center for Atmospheric Research wants to start now on assessments of "policy actions that might be invoked by governments" to reduce the threat of climate change.



Costing the CO_2

During the past 25 years atmospheric carbon dioxide (CO_2) has increased by 10 per cent. As more people burn more fuel and cut more CO_2–absorbing forests, an additional 25 per cent increase in CO_2 is conceivable for the year 2000.

The increase of atmospheric CO_2 is a problem because the gas absorbs infrared radiation, trapping some of the earth's heat that would otherwise escape to space. According to a current model, by the year 2000 the CO_2 increase could cause the average world temperature to rise by 1° C. Such global warming might be amplified in the polar regions, just where its effects might be most critical.

For example, glaciologists think the vast Antarctic glacier, which flows into the ocean on submerged bedrock, might easily disintegrate if average Antarctic temperatures went up only 5° C. Vast quantities of meltwater entering the world ocean would raise sea level by 15 to 25 feet.

Intrigued by what they call "the most dramatic of the possible CO_2-induced effects," Stephen H. Schneider of the National Center for Atmospheric Research and Robert Chen of the M.I.T. Department of Meteorology have attempted to foresee the result for U.S. coastal states. The prospect: massive flooding and dislocations.

- ☐ Some 11 million people and $110 billion of property could be affected.
- ☐ Boats could be launched from the steps of the U.S. Capitol.
- ☐ Some 40 per cent of Florida's population — all but four of its cities with more than 25,000 residents — would be submerged by a 25-foot rise.
- ☐ As many as 10 nuclear reactors on U.S. shorelines would have to be diked.

Indeed, dike-building would become a major preoccupation of government: a simple dam could save the entire Sacramento River Valley. But New Orleans — already below sea level and protected by a dike — and flat coasts such as Florida and Texas could hardly be saved. Economic impacts would be immense.

Will it happen? No one knows. The point of Drs. Schneider and Chen is not to predict a new form of doomsday but to emphasize the need for assessments of physical, economic, social, and political impacts of climate change. Should we invest now in limiting present CO_2 discharges so as to avoid the future costs of failing to do so? "It is time that we commit considerable talent to examining such questions," they told the American Association for the Advancement of Science this winter. — *J.M.* ☐

The Cancer Connection

Since the beginning of the century, mortality rates from infections and water-borne diseases have fallen sharply; from diseases of the heart, substantially. Homicides and accidental deaths are down, too. Only cancer is rising as a cause of death — at the rate of 0.7 per cent a year since 1900, according to figures cited by Marvin A. Schneiderman, Associate Director for Science Policy of the National Cancer Institute, at the annual meeting of the American Association for the Advancement of Science early this year.

The greatest increases in cancers are associated with what Dr. Schneiderman calls "the 'in-out sites' — the ones that are most likely related to what we eat, breathe, and excrete, and hence most likely related to our environment." Among these are lungs and colon, where cancer incidence has risen sharply.

There is plenty of circumstantial evidence to link this increase to factors in our environment and especially to what Dr. Schneiderman calls "the synthetic chemical revolution" which has accelerated so steadily since the end of World War II: even a quick inspection of maps shows a correlation between the location of large power plants east of the Mississippi, the fallout of their pollutants across the east

coast, and the distribution of cancer deaths among white males between 1950 and 1969: a "nasty overlap," said Dr. Schneiderman. "What happens in the Midwest may very well affect what happens to people who live along the East Coast."

There is evidence from Dr. Schneiderman's colleagues of "excessive rates of cancer in counties where paper, chemical, petroleum, and transportation industries are located." And there are recent and apparently significant annual increases in the incidence rates of cancers which are known to be related to certain industrial exposures — 0.4 to 1 per cent per year from 1947 to 1970, and a startling 1.4 to 2.3 per cent per year since 1970, *not* including the effects of cigarette smoking.

Though the cause-and-effect relationship may not be clear, said Dr. Schneiderman, "it would be nonsense to assert that none of the increase" in cancer incidence was related to industrial exposure and new industrial products.

Given that conclusion, how shall we respond? Not by panicking, finding a new cancer threat under every new chemical and asking the government to ban it, said Dr. Schneiderman. Not by burying our heads in the sand, ignoring the risks while enjoying the advantages of every new synthetic. Not by trying to make literal cost-benefit analyses, because you can't put a value on an unpolluted swimming hole or assign a cost to worrying about kepone in a Chesapeake Bay crab.

Dr. Schneiderman proposes a "sensible" middle ground: let people help themselves by avoiding known or suspected risks such as tobacco, nitrites, and saccharin; and let government help by appealing to their consciences (the seat-belt warnings on automobile dashboards) and their pocketbooks (the tax on tobacco, which perhaps should be made higher to be really effective in discouraging smoking), by enforcing safety in the workplace, and by adding to our meagre reserve of facts and correlations. — *J.M.* □

Ozone: Still Endangered

Is the ozone layer safe?

Not yet, despite the ban, now going into effect in the United States, on chlorine-containing gases in most aerosol products.

(Much simplified, the idea — as many readers will remember — is that nitric oxide and chlorine brought into the stratosphere may react to destroy ozone by stealing one oxygen atom from each ozone molecule to produce nitrogen dioxide or chlorine monoxide and molecular oxygen.)

A terrestrial sink for hydrocarbons and fluorocarbons released into the air is unlikely and we must assume they will reach the stratosphere, concludes Hanwant B. Singh of S.R.I. International (Stanford Research Institute) from his studies of the global distributions of these compounds. There is no oceanic repository, as some had hoped. Instead, said Dr. Singh, he has found a new threat to ozone: methylchloroform, a degreasing and dry cleaning

agent used instead of trichloroethylene, which was outlawed because it contributes to photochemical smog and is now also known to be carcinogenic.

Washington State University research reported to the A.C.S. suggests that fluorocarbons are still increasing in the troposphere; and from there they will probably migrate upward.

One piece of good news: Dr. Singh's data indicate that increasing use of nitrogen fertilizers has not led to the release of increasing amounts of nitrous oxide and ammonia into the atmosphere. Both would attack ozone if they reached the stratosphere. Dr. Singh has found no increase of nitrous oxide in the atmosphere over the past 27 months, and he concludes the "continued use of fertilizer is unlikely to pose a threat to the stratospheric ozone."

All this serves to emphasize the complexity of atmospheric (and stratospheric) chemisty. Important questions remain unanswered: How much fluorocarbon is in the atmosphere? Is the quantity increasing? How long is any given molecule likely to remain airborne? Today's data have uncertainties as great as 30 per cent. Now the Manufacturing Chemists Association is supporting a new program of worldwide, highly accurate measurements at observation stations in Samoa, Barbados, Ireland, and Tasmania. Within three years the error bars on atmospheric scientists' charts should be substantially shortened. The program was devised by Derek Cunnold, Frederick N. Alyea, and Ronald G. Prinn of M.I.T., and the tricky — and vital — business of calibrating instruments in the four stations is the responsibility of R. A. Rasmussen of the Oregon Graduate Center. — *J.M.* ☐

Innovation

Debunking Federal R & D

Since its inception during World War II, the federal research and development budget has grown to $40 billion — equal to one-fourth of the defense budget, or a bit less than three per cent of the Gross National Product. But with the war emergency long removed, the ponderous federal research and development establishment is in trouble.

For one thing, a noticeable imbalance of support exists between research and development activities — the development side has long enjoyed the lion's share. J. Derek DeSolla Price, Professor of Science History at Yale University, told an American Association for the Advancement of Science (A.A.A.S.) seminar in Houston earlier this winter that development activities absorb from 90 to 95 per cent of the total budget. By shortchanging research — and therefore, innovation — federal programs

"have accreted over the years," said Professor Price, and are today "at the best a finetuning of a tradition" likely to continue pressuring funds into areas unlikely to foster innovation. But the present size of the budget makes traditional increases "out of the question," he said, so that all research and development programs should be "debunked," and a "national shopping list" written, based on fresh priorities.

Alvin Weinberg, Director of the Institute for Energy Analysis at Oak Ridge, suggested six criteria for research that would help set those priorities. In general, he said, a research project destined for success should have these attributes:

☐ A "ripeness for exploitation" from the outset — in other words, the days of research for its own sake are numbered;

☐ A command of the interest of "people of high competence and purpose";

☐ For a science research project: the potential to enhance the rest of science (example: molecular biology);

☐ For a technological research project: the capability of actually achieving its goal (example of a failure: the War on Cancer);

☐ For a social science research project: the potential to enhance specific areas of social concern, such as health, peace, and race relations;

☐ For a research project requiring massive funding: powerful public approval and support.

Dr. Weinberg warned that once underway, a project's "failure to deliver the undeliverable" can produce severe disillusionment with science in general. Thus, the scientific community has a lot to gain — or lose — from the outcome of research programs and must therefore be in a position to referee directly the funding, as well as the merits, of proposed research.

No matter how promising a line of research may appear to its scientific progenitors, legislators must be sold on voting the supporting funds. George E. Brown, California Congressman, stated that we live in "an era of economic restraint and public skepticism as to the wisdom of governmental expenditure," and that "only those activities that display organizational inventiveness are likely to be favorably viewed" by Congress. And the high office of Science Adviser to the President, recently recreated — but, according to Congressman Brown, stripped of many of the powers envisioned in the National Science and Technology Policy and Organization Act of 1975 — has "very real limits to what can be accomplished." Without a "strong coordinating federal authority in science," scientists would do best to forge "stronger linkages" within their own ranks and form an "umbrella organization" that would work closely with Congress to rekindle enthusiasm and support for research, he said.

Rustum Roy, Chairman of the Science, Technology, and Society Program at the Pennsylvania State University at University Park, outlined a concrete approach to such an organization. The present process of allocating funds among current research and development programs is both "arcane and futile," said Professor Roy. "It follows a degraded Golden Rule: Them that has the gold makes the rules." Because of tradition and "prior commitments" government agencies and industry are very uneven in their support of basic research, he said.

The problem is not that we need more funding, he said. Additional funds do not necessarily bring more innovation or successful basic research. "The dollars allocated to basic research may no longer tell the true level of research effort. I believe that we can get much larger gains by designing a more efficient system." Some ideas from Professor Roy:

☐ Deregulate and decentralize the federal disbursal system by coupling universities and industry and providing federal support on a matching basis for specific contracts made between a university and a company or corporation. And rotate 50 per cent of the client universities every five years. The result: "decentralized problem selection and performance selection."

☐ Develop a disbursal formula plan that provides specific research pursuits with a fixed share of fiscal support. The continuation of support would rely on actual research productivity. Such automatic disbursement would eliminate most proposal writing, which Professor Roy feels wastes time better invested in actual research.

☐ Form a three-year-term national commission to evaluate science-related input from the public as well as from the science and engineering community. "If we leave the public behind as we've been doing, we are going to suffer from the kind of polarizations we have now," he said. (He pointed out that in 1958 the National Science Foundation's science education budget dropped from 50 per cent of the organization's total funding to only 10 per cent in 1975.)

There remained no doubt that Professor Roy, who organized this A.A.A.S. seminar, believes strongly in his innovative proposals. As he put it: "This system is so simple that it might even work." — *L.A.P.* ☐

Last Line

Scientists and Scientific Writing

"Today's scientific writing is pompous, murky, and dull, and it fails to communicate." So saying, Howard Lentzner, a chemist speaking last autumn before the Pacific Conference of Chemistry and Spectroscopy in San Francisco, threw a few more editorial brickbats at those scientists who, he continued, "may have great minds but can't write as clearly as they think."

The U.S. government and industry together spent $12 billion on written scientific materials — about 30 per cent of the total U.S. research and development budget, said Dr. Lentzner, now technical editor at the Lawrence Livermore Laboratory. He charged the nation isn't getting its money's worth because:

☐ Many scientific papers are written to impress rather than to inform;

☐ Scientists seem to have the generic tendency to obscure their ideas with a smokescreen of jargon and nouns freshly converted from verbs (and vice versa);

☐ Papers are written in an inductive manner — the good stuff that wraps it all up happens at the end. This is a sequence of development typical of research but not of writing.

Readers laboring through a glut of written materials will read only "the sentence that tells what the results of the research were," said Dr. Lentzner. If such a key sentence is buried somewhere within pages describing experimental and analytical procedures, it is not so likely to be read as it would have been if placed at the beginning of a paper. Indeed, a "lead" sentence or paragraph both summarizes and sells the paper to the reader.

If heeded, Dr. Lentzner's remarks (written up in the Department of Energy's *Energy Insider*) could cut down the time and energy expended by readers of scientific materials. Better writing means faster reading, and therefore more time for research. And isn't that what all that writing is about? — *L.A.P.* ☐

Beauty in the Laboratory

Aesthetics In Science
Judith Wechsler, ed.
Cambridge, Mass: M.I.T. Press, 1978,
180 pp., $12.50

Reviewed by Louis Vaczek

Casserine Toussaint

Six scientists were asked by the editor, Judith Wechsler who teaches history of art at M.I.T., to write these essays. The origin of the book was a course in which students studied " 'works of science' as one might works of art, examining the relation of form and content, and the intention and aspiration of the work." The purpose was to find links between the arts and humanities and the sciences, and Professor Wechsler invited scientists to share their thoughts with the students. Four of the lectures ended up in this collection.

If you are an artist who has had good courses in science, especialy in physics or chemistry, or if you are a scientist who has become interested in this apparently esoteric subject, you will enjoy the erudition, the organized searching on a broad level, and the excellent writing. The authors argue that the aesthetic experience in scientific work can be validated and is often critical in the development of theory.

Very briefly, Cyril Stanley Smith interprets crystalization as a hierarchical interlocking of small into larger structures, each level having meaning only as it intersects with the others; similarity with painting (Chinese landscape) is drawn. Philip Morrison begins with the fact that a universe consisting of monads is not an undifferentiated structure but is perceptible because of broken symmetries; as in art, we supply the missing parts. Arthur I. Miller recounts how Heisenberg rejected visualized models containing quantum theory by using a vocabulary that implied aesthetic considerations. Seymour A. Papert considers the experience in mathematics when the aesthetic and the functional facets seem to be related, and suggest a genetic capacity for this recognition rather than a logical construct. Howard E. Gruber examines Charles Darwin's groping toward a theory of evolution assisted by a symbolic tree of Nature as an image that stunningly illustrated for him the history of speciation. Geoffrey Vickers compares the medieval belief that knowledge is born of science *and* art with our current belief that science excludes art, and points to increasing need to recognize the validity of aesthetics in all knowledge.

Harness to Unbounded Imagination

The notion is not new that there lurks in rigorous formulations of natural law some kind of aesthetically pleasing factor — or a presence, perhaps intangible which is equatable with the aesthetic apprehension of form and content. These essays give a special and modern interpretation of an experience which is commonplace when Nature is scrutinized in a certain way. Here the observer is removed from the phenomenon that he is observing, so that he seems to himself to be unique, a visitor as it were, examining this world's fascinating details with a desire to understand their relationships, even their relationships to a Whole.

In the 19th century, a sense of beauty was freely spoken of as an accompaniment to the scientific realization that the universe was mathematically constructed in such a way that the touristing brain could perceive and untangle the simple formulae ruling various phenomena, each into its mathematical truth. The notion evolved from a belief in the fundamental harmony, or coherence, of the universe: could it be random, disjointed, when every portion fitted amazingly into equations? The delight of discovering yet another numerical relationship in tousled Mother Nature's anatomy was not just the creative "Eureka!" of disciplined research. It had metaphysical, though not sectarian, connotation. The 18th century's passion for collecting and cataloguing made direct use of aesthetic sensibility as a kind of alternative, in the Age of Reason, to religious dogma. Before the 18th century all scientists assumed that their investigations would uncover a Creation that perforce was aesthetically glorious behind the confusing non-perfection of the surface, where eternal verities became clouded with transient shapes.

Aesthetics and religion were always linked to keep Nature dressed in peek-aboo veils and shrouds and dazzling jewelry, carring a multitude of mysterious objects that merely resembled but were not really familiar things, and surrounded by all the animals and plants of Eden, each in its own way obedient to Nature and indifferent to Adam's exiled children.

But then, following Galileo's rebellion, the religious and aesthetic connotations of Newton's Laws put physics into a totally new vestment, a mathematical straight jacket; and a century later Antoine Lavoisier's Law of Conservation of Matter did the same for chemistry. Neither knew a thing about atoms yet their concepts, that ripped away the motley of mysticism, theology and magic, each of which entailed a view of Nature rich in aesthetic experience, were right and necessary precursors to probing for atoms. Why? Because, one can argue, the concept of conservation of momentum and of

weight in matter through all permitted transformations, is a more exciting and powerful aesthetic than the grand freedoms of unbounded imagination. The idea of the conservation of matter *and* energy is even more powerful.

Locating Beauty in the Laboratory

Today, the varieties of aesthetic experience in scientific work are generally considered to be private exultations, emotional rewards with apparently no common potential for usefulness as a guide to a fresh piece of research in industrial chemistry, for example, or in microbiology, astrophysics, or even particle physics where the aesthetic does appear ghostily in the vocabulary generated by the theory of quarks — strangeness, color, flavor. Its values depend on private senses and are qualitative, indicating our lack of understanding. Even this book, in which the writers convey the importance of aesthetics in their discoveries, is the result of diligent labor and pioneering by an art historian.

It would be interesting to know what percentage of students and working scientists have never felt euphoria when grasping the essential truth about some physical structure that measurement has laid bare. For it is precisely when contemplating form and content in the belief that their dimensions lead to scientific verities that aesthetic connections are recognized and described. It took us three centuries of quantitative flogging to domesticate Beauty and teach it not to meddle with laboratory technology, or creep into reports. Perhaps the flogging can now stop? Clearly, Beauty is still very much at home in the laboratory.

It is tempting to ask, however, after reading these essays: *where* is the aesthetic in scientific work? Is it in the old-fashioned balances poised on jeweled points in the field of the earth's gravity? In glass lenses ground to the sensitivity of the eye's own blood-bathed cells? In the particle accelerator? All these yield numbers; is it then in the actual numbers themselves, however they are obtained? Or one step deeper, in the formulae conjoined with those numbers? Is it diffused through nature and therefore through our own senses? Or is it, really, only a property of the brain — the observer's eye?

All the wrong theories of history, including last year's crop failures, were supported by an aesthetic rightness when they were first verbalized to fit around selected data. And they have been discarded not by more beautiful formulae but by more relevant data. It always comes back to measurement. It is the technology that separates science from non-science, or bad science or outdated science. Yet the aesthetic experience is always the same!

Aesthetic power seems to be related to quantitative connections between object and observer, whether in art or science. But whether because of this, or because of a totally different property, aesthetic *power* seems to be related to inevitability. The stronger the suggestions of inevitableness, the greater the aesthetic experience. Thus, all supernatural explanations of natural events have by definition a component of inevitability, just as does all primitive and religious and state art. But the supernatural is not nearly as powerful aesthetically as is the inevitability of a mathematical formula that bounds a specific phenomenon to total obedience that *we* can employ to predict future conditions in that phenomenon, an utterly useless hope with supernatural explanations. To make supernatural explanations useful, we must add mumbo-jumbo. Furthermore — though this is not touched upon in the book — scientific verities do give us far, far greater power in creating technology to control that phenomenon.

Perhaps the growing body of speculation on aesthetics in science is really asking the question: what is the function of the aesthetic?

Louis Vaczek has a degree in physical chemistry from McGill University. He has been senior science editor at Encylopaedia Britannica, *in addition to publishing a book on chemistry and several novels, and most recently has developed general science courses for adult education which he teaches at Roosevelt University.* □

Canning Concentrated Cancer Research

Cancer Crusade: The Story of the National Cancer Act of 1971
Richard A. Retting
Princeton, N.J.: Princeton University Press, 1977, 382 pp., $15.00

Reviewed by Thomas H. Maugh II

It seems fitting that Richard A. Rettig's history of the inception of the war on cancer has been published at much the same time that an unofficial armistice in that war has been declared. Rettig's history provides a casebook example of how events and personalities can converge to produce major legislative accomplishments; and the events which follow the National Cancer Act's passage in 1971 demonstrates how even the best-intentioned program can go awry if it is not built on a sufficiently firm foundation. Those events culminated in the recent, largely unnoticed announcement by the National Cancer Institute (N.C.I.) that perhaps the war on cancer had not been such a good idea after all, and that the agency would return to a more conventional approach to cancer research.

The Last Major Achievement

The proponents of the war on cancer had wanted their own version of the "moon shot": an independent cancer agency that could marshall all the forces of cancer research, organize them, and guide them quickly toward a cure for cancer, perhaps even in time for the nation's 200th birthday. They wanted to apply the highly-programmed techniques of systems management to follow up on leads that had already been developed. And, of course, they wanted more money. With these things, they promised, progress would be rapid.

Rettig, a senior social scientist at the Rand Corp., traces the history of the cancer crusade from its genesis in the minds of a group of "benevolent plotters" headed by Mary Lasker through the first year after the Act's passage. The author focuses on the unique confluence of people and events that made the act possible: the wealth and influence of Lasker and her dissatisfaction with the results of the President's Commission on Heart Disease, Cancer and Stroke; the conviction of scientists such as Emmanuel Farber and Solomon Garb that a cure for cancer was possible if only existing leads could be followed up on rapidly; the organizational skills and ability to compromise of Benno C. Schmidt; the effectiveness of Luke Cornelius Quinn in dealing with members of congress on behalf of the American Cancer Society; the combination of setbacks that placed Senator Edward Kennedy in the chairmanship of the Senate Health Committee; and the fear of Kennedy's presidential ambitions by then-President Richard M. Nixon. The story of how these factors combined to produce a massive infusion of money for cancer research and quasi-independence for N.C.I. is often fascinating.

Passage of the cancer act was a monumental achievement for cancer inves-

tigators who, not too long before, had been considered the illegitimate children of the scientific community because their research seemed so hopeless. But that was to be the last major achievement of the cancer community. Viewed from the perspective of seven years later, the scientific leads that were so highly touted at the time now seem less impressive. It was the equivalent of attempting to put on a man on the moon without first having demonstrated he could even fly in space.

Power in the Hands of a Few

The administrators of the Institute had not been proponents of the war on cancer and had, in fact, not even been consulted by Schmidt's commission as it drew up its battle plans. Nonetheless, it became their responsibility to produce the quick results so easily promised by others. Spurred by this need, N.C.I. invested a major proportion of its new money into what then appeared to be its two most promising leads — environmental causes of cancer and oncogenic viruses.

The investment provoked a sharp expansion of the contract system, whereby key investigators at N.C.I., in effect, hired private firms to carry out a substantial portion of their research. These contracts produced a marked increase in the number of scientific papers bearing the names of those investigators, but little real progress.

Two separate N.C.I. panels have suggested that this poor showing resulted because the contract system put too much power into the hands of a relatively small group of scientists. Members of this group were not only free to design research projects with little or not input from other investigators, but also monitored the progress of the projects. Without the cross-fertilization of findings from other areas of biomedical research, some areas of cancer research began to grow sterile.

The only way to restore this cross-fertilization, N.C.I. has reluctantly concluded, is to renew emphasis on the time-honored tradition of independently proposed research grants. The Institute is also separating review and evaluation procedures from the grant–and contract–giving process in an attempt to achieve a somewhat more objective assessment of research progress. These changes will provide more flexibility to accomodate valuable findings in other fields. "There are clearly areas where programming is necessary," says N.C.I. director Arthur C. Upton, but "there are still vast areas of research where we are unable to lay out a blueprint and a timetable."

One must not, however, draw the conclusion that the promoters of the war on cancer were the scientific equivalent of a military-industrial complex seeking their own gain. There was good reason to believe then, just as there is now, that there are very promising leads that need to be followed up. If some investigators have been overzealous in promoting their own research as the best path to a cancer cure, that is certainly not an occurrence that is unique to the cancer community. It is unfortunate that the crusade became sidetracked, but that situation now seems to be rectified. Perhaps a fresh infusion of ideas will prove to be just what is necessary to turn those leads into successes.

Thomas H. Maugh II is on the Research News Staff of Science *magazine.* □

Backstage at the White House: Science, Policy, and Power

A Scientist at the White House: The Private Diary of President Eisenhower's Special Assistant for Science and Technology
George B. Kistiakowsky
Cambridge, Mass.: Harvard University Press, 1976, xvii + 448 pp., $15

Reviewed by James Everett Katz

Reading George B. Kistiakowsky's *A Scientist at the White House* is much like the job of being presidential science advisor: both are alternately fun and dreadful, exciting and tedious. The diary of his years as President Eisenhower's special assistant for science and technology, covering 1959 and 1960, is episodic, undigested, and fractured, but reels with fresh impressions and maintains a tempo of currency. Dr. Kistiakowsky shares with us the kaleidoscope of studies, meetings, memos, parties, and backstabbing which eventually resulted in, among other things, both the United States science policy and national security posture. The uneven journey is rewarding, though. Implicit in the diary are a number of lessons which have significant ramifications for contemporary science advice.

Strikingly, many White House problems have remained relatively unchanged over the last two decades. Then as now, White House agendas ranged over arms talks, relations with Cuba, intelligence estimates, inflation, and the presence of carcinogens in foods. Its historical vantage point also encourages ironic conclusions about the nature of "progress."

Dr. Kistiakowsky's diary provides a diffuse, albeit unintentional, guide to both the opportunities, dangers, and pitfalls of presidential advising, and to the tactics of counseling political leaders who breathe the rarified White House atmosphere.

Contest for Confidence

The White House resembles a feudal system in which fiefdoms of authority wage constant battle; the contest is deadly earnest, softened only by a gentlemanly veneer.

From Dr. Kistiakowsky's diary emerges a science advisor who must screen com-

peting persuasions. Reality reflected in data is highly plastic. Individuals using the same information will arrive at conflicting interpretations which, not surprisingly, conform to their own predispositions. The same strategic deployment or intelligence estimates could be used to argue either that the United States was grievously weaker than or comfortably superior to the Russian military forces.

But Dr. Kistiakowsky makes it clear that he was working singularly for the president; he sought to ensure that a full range of options were presented, that all policy recommendations placed the president's interests foremost, and that the president's wishes were indeed carried out. As best he could Dr. Kistiakowsky repulsed the self-serving initiatives of the Defense Department, the scientific community, academe and the host of other interests converging upon the White House.

This devotion gave Dr. Kistiakowsky the influence he needed to be effective, yet he exercised that power judiciously. Dr. Kistiakowsky wisely avoided clashing with President Eisenhower's budget director, Maurice Stans, and diplomatically declined to insist on direct participation in science budget review sessions. Overseeing financial wranglings has too often pointlessly absorbed the energy and political capital of later science advisors. Dr. Kistiakowsky preferred to express concern with budgets indirectly at a higher level.

He was able to plumb administration officials' motives and design tactics to either build upon or block opposing coalitions accordingly. His politically astute qualitites were vital in avoiding traps engineered by his opponents and inadvertently created by his allies. A theatrical nature and capacity for shrewd judgments won him the confidence of the president, and tell us that the science advisor's authority is in significant part derived from his rapport with the president. But this relationship itself is not unaffected by the political needs of the president and his cognizance of the potential utility of scientific and technical judgments.

Dr. Kistiakowsky's experiences constitute a much needed corrective for the conventional wisdom which holds that the science advisor ought to have statutory responsibilities in advising the President and participating in making the budget. Undoubtedly, access to key administration figures and significant evaluations to recommend are the guts of science advising. But this process can neither be legislated nor imposed from outside the White House. Rather it must result from the policymaker's real desire for advice. Obviously President Nixon, who disbanded the presidential science advisory offices, felt that such advice was harmful or at least useless to him. Even when the policymaker feels that advice will help rather than hinder him, the organizational features that will allow the decision-maker to capitalize on the advice proferred must exist, and federal agencies are not always so open, as was demonstrated by Atomic Energy Commission Chairman John McCone's constant duplicity in arms control and research policy discussions.

Unfinished Business

As revealed in the diary, the various decisions were constantly being reconsidered. Examples are numerous, such as how many of what type of missiles should be built or what constitutes adequate test-ban inspection safeguards. Revisions occurred partially as a result of the fact that only the most divisive and difficult decisions reached the White House; the easy decisions could be resolved in lower bureaucratic echelons. Issues brought to the president's desk were highly contentious and all sides were vigorously supported by implacable and powerful forces. Though clear-cut verdicts were made and many projects were arrested (such as the nuclear-powered airplane, ANP), inevitably its proponents would return for another round to win approval for their program's basic idea (such as nuclear-powered weapons or strategic aircraft by ANP advocates).

Numerous other provocative insights into the politics of advising the president and the role of scientists in this process, as well as various facets of the creation of American policy, are embedded in the diary. It is regrettable that neither Dr. Kistiakowsky nor the author of the book's comprehensive introduction saw fit to underscore these principles. Nonetheless, its countless sage examples and entertaining stories recommend this book to those who are interested in the government-science nexus.

James E. Katz is a research fellow at the Center for Science and International Affairs at Harvard University's Kennedy School of Government.

Bags of Coins: Are They True or False?

Allan Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he has just been promoted to associate professor in the Mathematics Department (where he is also coordinator for computer mathematics) at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

This is written on January 1, so let me wish all of you a (belated) happy new year. 1978 was a good year for me, and I am looking forward to 1979; and I hope you feel the same way.

In December I attended the Association for Computing Machinery annual conference in Washington, D.C., and as usual the North American Computer Chess Championship was held concurrently. To the surprise of many (your editor included), the current world champion, CHESS 4.7 from Northwestern University, was soundly beaten by BELLE, from Bell Labs. This latter program, written by Ken Thompson, runs on a minicomputer, the PDP-11 model 70, whereas CHESS 4.7 utilizes a supercomputer, the CDC CYBER 176. This was not, however, a David vs. Goliath encounter. The BELLE computer was greatly enhanced by some chess-specific hardware built by Joe Condon, also from Bell Labs. The level of play produced by the top contestants was quite high, at least class A. BELLE, itself, must surely be in the expert range. Although some optimists are starting to talk about a computer as world champion within ten years, I stick with my prediction that 20 years would be closer.

Problems

M/A 1 A cute cryptarithmetic problem from the late R. Robinson Rowe:
Evaluate this 4-story gabled HOUSE on its GROUNDS so generous that there is both a front yard and a back yard.

```
      U
    O U S
  H O U S E
  H O U S E
  H O U S E
  H O U S E
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G R O U N D S
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M/A 2 Here's a bridge problem from Noland Poffenberger, who wants South, on lead, to make the remaining six tricks with hearts as trump:

	♠— ♥8 7 ♦J 5 ♣A 2	
♠Q 7 ♥— ♦Q 7 ♣J 3		♠J 6 ♥— ♦10 8 6 ♣8
	♠10 9 ♥— ♦A K 9 ♣10	

M/A 3 Emmet Duffy sent us the following counterfeit problem:
Eleven open bags, numbered 1 to 11, each contain two coins. Ten bags contain genuine coins all of the same weight. One bag contains false coins which differ slightly in weight from genuine coins. The two false coins weigh the same but a false coin is either 10 grains heavier or 10 grains lighter than a genuine coin. You are given a balance scale and 20-grain weight. Using the balance scale two times only, find a method to identify the false coins and tell whether they are heavy or light. Placing stated coins on stated sides of the scale, and, if required, placing the weight on the scale, shall be considered a use of the scale.

M/A 4 Avi Ornstein and Hugh Thompson each submitted the same variant on **1975 DEC 3:**
Find a collection of (ordinary) English words that contains the fewest possible total number of letters while including each of the 26 letters at least once.

M/A 5 Baranow needs some help in unicycling across a rotating table:
A unicyclist moving at a velocity v enters the north end of a table rotating at an angular velocity w. He wishes to leave via an exit ramp at the south end of the table in the minimum possible time, t. Find t and the path required as a function of v, w, and r (the radius of the table).

Speed Department

M/A SD 1 Here is another problem that originally appeared in *Technology Review* in advertising for Calibron Products — this one from February, 1942 (*diagram is to the right*):
A reel capable of holding 4,000 feet of steel tape 0.003 inch thick is to be designed. If the inner (hub) radius is 4 inches, can you derive (in your head) a formula and rough numerical value for the outside radius R?

M/A SD 2 Joe Horton wants to know what algebraic expression (involving a limit) defines a square.

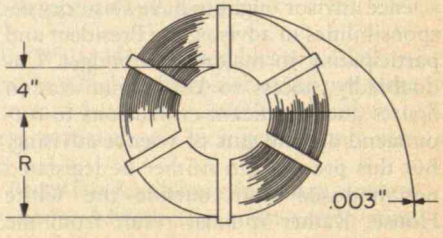
Solutions

J/J 1 (as modified in November)

	♠7 3 ♥Q J 3 2 ♦5 2 ♣A K 5 3 2	
♠A Q 2 ♥A K 7 6 5 4 ♦A Q ♣J 6		

With South the declarer at six hearts, West leads the ♥10. South thinks a moment or two and plays a heart from dummy. East discards a diamond. What is the best play to make six hearts? If possible, supply the probability of success.

The proposer has a very detailed solution with a 95.7-per-cent probability of success. Due to space considerations, however, I print below Matthew Chen's solution instead, even though the latter has a probability of success nearer to 95.1 per cent:
Trick 1: ♥J, ♥4. Trick 2: ♠3, ♠Q (if ♠K doesn't appear); if the finesse succeeds, South draws trumps and claims. Otherwise, say West returns a heart; if spades are 8-0, South draws trumps and takes the diamond finesse (after testing if ♣Q drops singleton). Else, South plays trick 3: ♥2, ♥K. Trick 4: ♣6, ♣K. Trick 5, assuming ♣Q did not drop: ♣A, ♣J. Trick 6: ♣2, ♥A. Trick 7: ♥5, ♥Q. Trick 8: ♣3, ♥6. If West can ruff at trick 4 or 5, then the contract fails. If clubs split 2-4, 3-3, or 4-2, then South cashes ♠A, ruffs a spade, and discards ♦Q on the last club. If clubs are 5-1 or 6-0, South takes the diamond finesse (unless ♣Q is a singleton). At first, the possibility of a singleton ♣Q is ignored in the following analysis of South's winning chances. South wins whenever the ♠K is favorably located, unless all of the following occur: spades break 0-8,



clubs split 5-1 or 6-0, and West holds ♦K. West holds 10 unknown cards, and East has 12 unknown cards, so the probability that (East holds the ♠K and South can win) is

$$\frac{\binom{21}{11}}{\binom{22}{12}} - \left(\frac{\binom{8}{0}\binom{6}{6}\binom{7}{3}}{\binom{22}{10}} + \frac{\binom{8}{0}\binom{6}{5}\binom{7}{4}}{\binom{22}{10}} \right)$$

$$= \frac{6}{11} - \frac{35}{92378} \approx .545076$$

If the ♠K is offside, South wins when clubs are 2-4, 3-3, or 4-2, and also when (clubs are 5-1 or 6-0 *and* ♦K are on side). After trick 2 South knows whether spades are 8-0; if they are not, West has nine unknown cards and East 11 unknown cards. So let E_1 be the event that West holds ♠K, E_2 that spades are 8-0, E_3 that East holds ♦K, E_4 that clubs are 2-4, 3-3, or 4-2, E_5 that clubs are 5-1 or 6-0, and $\bar{E}_2$ that E_2 does not occur. Then the probability that (E_1 obtains and South can win) is

$$P(E_1)\{P(E_2|E_1)P(E_3|E_2E_1) + P(\bar{E}_2|E_1)$$

$$[P(E_4|\bar{E}_2E_1) + P(E_5E_3|\bar{E}_2E_1)]\}$$

$$\approx 0.395509, \text{ since}$$

$$P(E_1) = 5/11,$$

$$P(E_2|E_1) = \frac{\binom{7}{7}\binom{14}{2}}{\binom{21}{9}} = \frac{1}{3230},$$

$$P(E_3|E_1E_2) = \frac{\binom{13}{\alpha}}{\binom{14}{2}} = \frac{6}{7},$$

$$P(\bar{E}_2|E_1) = \frac{3229}{3230},$$

$$P(E_4|\bar{E}_2E_1) = \frac{\binom{6}{2}\binom{14}{7}}{\binom{20}{9}} + \frac{\binom{6}{3}\binom{14}{6}}{\binom{20}{9}} + \frac{\binom{6}{4}\binom{14}{5}}{\binom{20}{9}},$$

$$P(E_5E_3|\bar{E}_2E_1) = \frac{\binom{6}{5}\binom{13}{4}}{\binom{20}{9}} + \frac{\binom{6}{6}\binom{13}{3}}{\binom{20}{9}}.$$

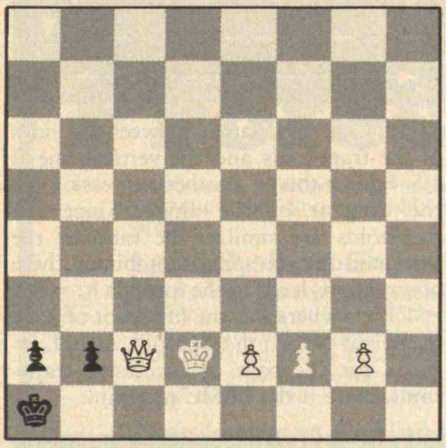
Hence South makes his contract with probability ≈ .9406 plus P ((spaces are 0-8 and clubs are 5-1 with ♣Q singleton, and West holds ♦K) or (West holds ♠K and ((clubs are 5-1 with ♣Q singleton and West holds ♦K) or (clubs are 1-5 with ♣Q singleton)))).

$$.9406 + \frac{\binom{7}{4}}{\binom{22}{10}} + \frac{\binom{14}{3}}{\binom{22}{10}} + \frac{\binom{15}{8}}{\binom{22}{10}}$$

≈ .9406 + .01056838 ≈ .95115 (exact to five digits).

Also solved by Matthew Fountain, Matthew Chen, Elmer Ingraham, Rudolph Evans, Andrew Purbrick, and the proposer, William Butler.

NOV 1 White is to move and win:



Despite the fact that we mistakenly stated that "White moves down the page," many readers solved this problem. They all agree that the solution is:

1 Q — B3	K — N8
2 Q — Q3*	K — R8
3 Q — Q4	K — N8
4 Q — K4*	K — R8
5 Q — K5	K — N8
6 Q — B5*	K — R8
7 Q — B6	K — N8
8 Q — N6*	K — R8
9 Q — N7	K — N8
10 Q — R7*	K — R8
11 Q — R8	K — N8
12 Q — R1 mate	

Solutions received from Smith Turner, Gerald Blum, Richard Denton, Jordan Wouk, Jon Thaler, Bill Camperlino, Abraham Schwartz, William Butler, Winthrop Leeds, Matthew Fountain, Robert Kimble, and the proposer, Steve Slesinger.

NOV 2 Find all positive integer solutions of $A^2 + (A + 1)^2 = C^2$.

Although several readers gave short "proofs" that 3, 4, or 5 is the only solution, there are, in fact, infinitely many others. Steve Feldman noted that a detailed discussion can be found in Beiler's *Recreation in the Theory of Numbers* (Dover, 1974), and Emmet Duffy submitted the following:

Noting that the proposer wants to know all positive integer solutions but not how to get them, we do not have to use the Pell equation. There are an infinite number of solutions; the first two values of A are 3 and 20 and for C, 5 and 29. The values of A are a series where any number (after the first two) is found by multiplying the previous number by 6, subtracting the number before the previous number, and then adding 2. The value of C is found in a similar manner except do not add 2. The first ten values of A and C are:

A	C
3	5
20	29
119	169
696	985
4,059	5,741
23,660	33,641
137,903	195,025
803,760	1,136,689
4,684,659	6,625,109
27,304,196	38,613,965

Also solved by Matthew Fountain, Frank Carbin, Winthrop Leeds, William Butler, Wayne Adams, Grant Sharman, Roger Milkman, Harry Zaremba, Winslow Hartford, John Prussing, Judith Longyear, Gerald Blum, Smith Turner, Jack Crawford, Randall Rathbun, Robert Kimble, Neil Cohen, Avi Ornstein, Gerald Stills, William Pasfield, Robert Kennedy, and the proposer, Thomas Mahon.

NOV 3 In tennis, to win a game you must meet two conditions: a) win four or more points, and b) win two more points than your opponent — thus (dispensing with the fancy terminology of tennis scoring) winning scores are 4-0, 4-1, 4-2, 5-3, etc. If one player's probability of winning any given point is p, what is his probability of winning any given game? If winning a set requires winning at least six games, and at least two more games than your opponent, what is this player's probability of winning any given set?

The following solution is from Gerald Blum:

If one player's probability of winning a point is p, that player's probability of winning a game is given by

$$g = p^4 + 4p^4(1 - p) + 10p^4(1 - p)^2$$

$$[1 - 2p(1 - p)]^{-1},$$

where the term in brackets is the sum of an infinite series. The first term is the probability of winning 4-0, the second the probability of winning 4-1 (the winning player must win the last point), and the coefficient of the bracket is the probability of winning 4-2. The probability of winning 5-3 is the probability of winning the last two points after getting to a 3-3 deuce; it happens to be $2p(1 - p)$ times the probability of winning 4-2. The probability of winning $(n + 2)$ to n is the probability of winning the last two points after being at deuce at every point from 3 to n. To get from one deuce to the next, each player must win one point, but in either sequence; the probability of this is $2p(1 - p)$. The probability of winning $(n + 2)$ to n is thus the quantity $2p(1 - p)$ all to the $(n - 3)$ power times that for winning 5-3, and thus the quantity $2p(1 - p)$ all to the $(n - 2)$ power times that for winning 4-2. Summing over all possible winning scores gives an infinite geometric series with the sum indicated above. We can combine terms to give

$$g = (15 - 34p + 28p^2 - 8p^3)p^4/$$

$$(2p^2 - 2p + 1).$$

With some algebra, one can confirm that replacing p by $(1 - p)$ and g by $(1 - g)$ everywhere above gives the same answer. Following essentially the same logic, one gets for the probability of winning a set

$$s = g^6 + 6g^6(1 - g) + 21g^6(1 - g)^2$$

$$+ 56g^6(1 - g)^3 + 126g^6(1 - g)^4$$

$$[1 - 2g(1 - g)]^{-1}.$$

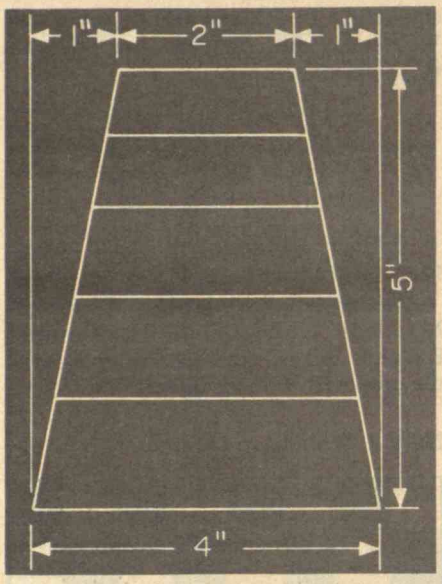
One could, of course, express s in terms of p by substituting, but there's a limit to how much slog even I will go through!

Also solved by Randall Rathbun, Jack Crawford, Smith Turner, Judith Longyear, Winslow Hartford, Harry Zaremba, Sidney Shapiro, Ernesto Ramos, William Butler, P. Jung, Matthew Fountain, Michael Fuerst, Wayne Baxter, and the proposer, Edwin Strauss.

NOV 4 The figure shows five similar trapezoids formed by drawing lines parallel to the base. What are the heights of the trapezoids? *(see diagram on top of the next column)*

James Boettler sent us the following solution, which he says was done "while watching 'Heroes of the Bible' on television"; he includes a BASIC program to do the calculations:

Draw a vertical line from the top of the trapezoids to the bottom, and observe that



the tangent of the angle between the sides of the trapezoids and the vertical line is 1/5. Equate this to another expression for the tangent of the angle. Since the trapezoids are similar, the ratio of the sides must be the same. Combining these observations leads to the formula $h_n = 5(P - 1)P^{n-1}$, where P is the fifth root of 2, h_n the height of the nth trapezoid. Also, $L_n = PL_{n-1}$ for the base of successive trapezoids. Here is the BASIC program:

```
 90 PRINT " HEIGHTS", " BASES"
100 P = 2^.2
110 H=L=0
120 L1=2
130 FOR N=1 TO 5
140 H1 = 5*(P-1)*P^(N-1)
150 L1=P*L1
160 H=H+H1
170 L=L1+L
180 PRINT H1, L1
190 NEXT N
200 PRINT "SUM OF HEIGHTS IS"; H
210 PRINT "SUM OF BASES IS"; L
990 END

READY

RUNH
 HEIGHTS        BASES
 .743493        2.2974
 .854049        2.63902
 .981045        3.03143
 1.12692        3.4822
 1.2945         4
SUM OF HEIGHTS IS 5.00001
SUM OF BASES IS 15.4501
```

Also solved by Mike Fuerst, Homer Stewart, Matthew Fountain, Richard Mackler, Jerome Taylor, Bill Marshall, Winthrop Leeds, Norman Wickstrand, Everett Leroy, William Butler, Arthur Hovey, Frank Carbin, Charles Norton, Andrew Combie, Sidney Shapiro, Temple Patton, Harry Zaremba, Mary Lindenberg, Jon Thaler, Winslow Hartford, John Prussing, Judith Longyear, T. Benton, Gerald Blum, Smith Turner, Elwyn Adams, Art Porter, Jack Crawford, Peter McMenamin, Avi Ornstein, Gerald Stills, Naomi Markovitz, Randall Rathbun, Roger Milkman, and the proposer, Emmet J. Duffy.

NOV 5 What is the English word with the largest number of consecutive letters appearing in alphabetical order?

Looking at everyone's results, I find that the largest number of consecutive letters is four. Examples include "understudy," "overstuffed," "limnophilous," and "gymnopedia." Solutions were received from Winthrop Leeds, Steve Feldman, P. Michael Jung, Daniel Bloom, Cary Silverston, D. Terence Langendoen, Gerald Blum, Emmet Duffy, Randall Rathbun, Arthur Delagrange, and the proposer, Dave Rabinowitz.

Better Late Than Never

1977 DEC 5 Edwin Comfort has responded.

1978 M/A 2 E. Phillips found the same improved solution noted in this department for December/January, and Albert Mullin submitted the following:

The "factor champions" discussed by Engel were discovered by the great Indian arithmetician S. Ramanujan about the year 1913. He called them "highly composite numbers." Using sophisticated techniques from real analysis, he studied their properties in a lengthy paper published in the *Proceedings of the London Mathematical Society* in 1915. On the other hand, Engel may have the *longest* list of highly composite numbers in existence. To this extent, it is just possible that the Indian Mathematical Society might be interested in the "complete" list. However, in recent years that society has expressed more interest in abstract matters and just might *not* be interested in such a list of numbers.

M/A 5 Winslow Hartford has responded.

J/J 4 Avi Ornstein has responded.

J/J 5 T. Benton and Elwyn Adams have found ruler-and-compass constructions.

A/S 1 Mike Bercher and Von Fischer have responded.

A/S 3 Leon Bankoff has a solution that does not require trigonometry.

A/S 4 W. Stiehl, Walter Nissen, and Jack Crawford have found several specific solutions. Mr. Nissen is the leader with the

following complete list up to one billion: 1, 2, 3, 4, 5, 6, 7, 8, 9, 153, 370, 371, 407, 1634, 8208, 9474, 54748, 92727, 93084, 548834, 1741725, 4210818, 9800817, 9926315, 24678050, 24678051, 88593477, 146511208, 472335975, 534494836, 912985153.

OCT 1 Timothy Maloney and Jack Crawford have responded.
OCT 2 Elwyn Adams and Mahlon Stilwell have responded.
OCT 3 Mahlon Stilwell has responded.
OCT 4 Mahlon Stilwell, Joe Stockert, Von Fisher, Judd Schwartz, and Jon Thaler have responded. Mary Lindenberg noticed that this problem was also **1972 O/N 2.**

Proposers' Solutions to Speed Problems
M/A SD 1 Equate the area of the thin edge of the tape (114 square inches) to π * (R*R − 4) and solve for R. The answer is approximately eight inches.
M/A SD 2 $\lim_{n\to\infty} x^{2n} + y^{2n} = 1.$

Cowen

Continued from p. 11

Admittedly, the flashing lights seen at an angle can look wierd. Some perceptual mistakes probably are inevitable. However, Mr. Hendry says: "None of this rationale begins to 'explain' the distorted observations regarding 'domed discs,' 'treetop heights,' gigantic size [large as a football field] estimates, claims of being deliberately followed in cars, false assumptions that the plane's sign turning off was equal to the U.F.O. rushing away faster than the eye could follow . . . and, most of all, the wholly unwarranted emotional reactions (including fear) exhibited by the eyewitnesses and the immediate, nearly universal conclusion that the advertising plane was from outer space." Mr. Hendry concluded that this is indicative of "pervasive emotional climate that appears to be surrounding the entire U.F.O. subject, one that succeeds in distorting even the most commonplace sightings into exaggerated 'miracles.' "

It is this emotionalism that seems so puzzling. Dr. Leibowitz says he has no scientifically based explanation for it. However, he thinks it may be at least partly due to widespread distrust of science and consequent desire to put science down. "I think society in general thinks science has gotten too big and many people like to think science doesn't have all the answers," he says.

He may be right. Certainly, the irrational belief in flying saucers involves rejecting scientific method and standards of evidence and credibility. There is a research challenge here for social scientists to find out just what is involved. As Mr. Hendry points out, the I.F.O.s (Identified Flying Objects) offer "a wealth of evidence . . . about U.F.O.logy's old bugaboo: the reliability of human testimony." Meanwhile, it's worth recalling the biblical advice (Proverbs 14:15): "A simple man believes every word he hears; a clever man understands the need for proof." □

Science and Its Social Context

In France, where railroads are owned and operated by the state, they are efficient and widely admired; in the U.S., where railroads developed in a tradition of private ownership, they now represent "a demoralized system of transport sustained at great public expense."

But the privately-owned telephone system in the U.S. sets a high standard for the world, while the state-owned system in France is "in a state of crisis."

Despite growing scientific evidence of cigarettes' association with disease, efforts by the governments of both France and the U.S. to discourage their consumption are less than effective; but they've had an unexpected by-product: cigarette manufacturers have changed their products to make them less dangerous.

The ideas of "district heating" — central heating plants serving urban neighborhoods — and "co-generation" — equipment to make use of by-product heat from industrial processes — have the potential for important fuel savings. Some of these technologies have been embraced in France but almost none is now being planned in the U.S.

Cities everywhere have grown since World War II — a great rural-to-urban migration. In the U.S. this growth has brought the rural poor to city centers abandoned by most affluent city-dwellers who use countless automobiles on miles of expressways to commute from the suburbs. But in France the same pressures for growth led to a flowering of city centers served by vigorous public transport with the economically disadvantaged confined to the outskirts.

On first reading, this recital of issues may seem as unsorted as the spars in a game of pick-up-sticks. But through each run two questions: How is technology used and changed by the political process, and how is the process of public decisionmaking changed by scientific and engineering developments?

It was two years ago that Walter A. Rosenblith, Provost of M.I.T., and the late Bernard P. Gregory, who was then director general of the French Centre National de la Recherche Scientifique (C.N.R.S.), found themselves sharing a lively interest in the dilemmas exposed by these — and similar — issues in the interrelations between science, technology, and the political process. They hoped a serious, cross-national study of enigmas such as these would contribute to our understanding of the interface between technology and society and lead to better management of the processes of decision-making as they interface with scientific progress.

For two years teams of U.S. and French scientists, engineers, physicians, urbanists, and social scientists have been studying together the five case examples cited in the opening paragraphs of this account, comparing French and U.S. developments and seeking useful lessons about science and decisionmaking. The effort culminated at a symposium in Paris in February named in Dr. Gregory's honor — he had died suddenly a year earlier while serving as senior policy adviser to the French government.

Five conclusions from Professor Eugene B. Skolnikoff of M.I.T., reporting for a group of experts who analyzed the five case studies:

☐ Policy issues never turn on science and technology alone; technological factors always interact with political and economic factors — and often with others, too.

☐ New technology almost always requires government intervention and planning, and the momentum of science and technology is such that government intervention and planning grow ever more difficult.

☐ There is seldom agreement among technologists on the technological factors and their impact in important policy issues; but this does not mean that all technological analysis is flawed. Furthermore, the extent of the differences among technologies often correlates with the extent of the policy differences which become the subject of public debate.

☐ Access to scientific information and analysis is necessary but not sufficient condition for effective participation in decision-making.

☐ Scientific information, no matter how compelling it seems to those who produce it, has little effect on decision-making unless strong support is present.

After listening to two days of case histories discussed in detail, this observer has the temerity to add four somewhat more pragmatic — and perhaps obvious — observations:

☐ The perpetrators of a new technology — its inventors and entrepreneurs — seldom have much to say about how well their creation serves social needs.

☐ Technology is a creature of its environment, and it is notably responsive to its economic environment.

☐ Technology seldom yields gracefully to direct regulation; but regulating technology by manipulating its environment is a promising and underutilized strategy.

☐ Acceptance or rejection of a new technology often depends on the extent of the changes it seems to impose — the more change, the less welcome.

Railroads: Nurtured or Starved?

Consider first the case of the French and American railroads. By 1882 — after a slow start because of parliamentary indecision and maneuvering, the French government was the owner and operator of a 9,600-mile rail system developed according to a master plan laid down in the 1830s and 1840s. It was built and operated entirely by engineers trained in the Ecole des Ponts et Chaussées.

By about the same time, the U.S. had dozens of railroads, the largest being about as large as the French system. They had developed as economic opportunity seemed to dictate with almost no government intervention.

The reasons for this difference in development of a basic technology in France and the U.S. is clear, said Professor Alfred D. Chandler, Jr., of Harvard Business

School: there was no tradition in the U.S. for government operation of common carriers, and it occurred to no one that the government might intervene to operate or even regulate what turned out to be a major factor in the development of American urban systems, financial strategies, and management skill. In France there was a tradition of government management and a central source of expertise, and the railroads prospered as recipients of "well-honed engineering . . . and established organizational" traditions. Monopoly, not oligopoly, was the natural French pattern.

But from American oligopoly eventually came adversity: competition among U.S. railroads led to the granting of preferential rates to preferred (mostly long-haul) customers. The aggrieved short-haul customers presently took their complaints of discrimination to Washington, where they found a ready ear, said Professor Chandler. The result was government intervention in rate-making which had the effect of injecting politics, reducing profits, and reducing the flow of new capital. U.S. railroads have been suffering downhill ever since.

Though the French argued that the decision to electrify their railroads was a major factor in the railroads' current superiority, Professor Chandler expressed doubt. No innovations in technology are needed to explain the French superiority. "The long tradition of government-business cooperation . . . in France gave that country . . . a significant edge over the U.S. in the maintenance of its transportation infrastructure."

What about the telephone, a case in which U.S. private industry has clearly out-paced a French public enterprise? In the first place, said Michel Frybourg of the Institut de Recherche des Transports and Louis-Joseph Libois of the Cour des Comptes, there was no central authority such as the Ecole des Ponts et Chaussées on which the French government could rely for telephone expertise; ever since its origins in 1880, decisions concerning the French telephone system came from "many different parties and actors," they wrote. In contrast, the American Telephone and Telegraph Co. emerged quickly into leadership in the U.S. because it held the basic patents and because it chose to develop upon these a far-sighted research and development program, said Ithiel D. Pool, Professor of Political Science at M.I.T. A unified industry was quickly built by A.T. and T., and there was no repetition of the railroads' destructive intramural competition.

The two cases, said Professor Pool, "reveal in sharp relief the difference in incentive structure between a system whose compensations depend on political permissions and one driven by the constraints of private capital-raising."

Technology vs. the Status Quo

The same sort of contrast between traditions of monopoly and oligopoly seems to explain the radically different courses of post-war urban development in the U.S. and France. U.S. consumers after World War II emphatically chose to live in the suburbs and drive to work in the city using the cheap energy which had been a cornerstone of the U.S. economy, and the U.S. government made these dreams of individuality easy to fulfill with massive

highway building and generous mortgage assistance. In contrast, the French response to that country's "massive flow" of population from country to city was sharp and direct: some 2 million urban dwellings were built between 1945 and 1960, and even as late as the 1960s three-fifths of all French housing starts were controlled by central government decisions, said Georges Rottier of the Sorbonne.

But now the scene is changing in the U.S., said Professor Alan A. Altshuler, Head of the Political Science Department at M.I.T.: there has been a remarkable shift in government policy mandated by U.S. voters since the mid-1960s: money formerly spent on highways is now going to mass transit, and "gas-guzzling" automobiles are to give way to nonpolluting, small cars. Yet when it comes to marketplace decisions, the U.S. public appears to reject these priorities, demonstrating hostility "to any scheming by government to reduce automobile use" and resisting all lures of mass transit and other forms of ride-sharing, said Professor Altshuler.

The fact revealed by this dilemma is that Americans like the status quo, said Professor Altshuler. They oppose new highways because their construction disrupts neighborhoods, yet they reject new travel modes because these necessitate changing established behavior patterns.

Science, Cigarettes, and Public Decisions

When scientists established the link between cigarettes and first cancer and later other forms of human disease, they opened a whole new arena for confrontation between science and the public: What is government's responsibility to protect citizens from this newfound hazard, and how shall that responsibility be fulfilled?

Some options were closed. "Over one-third of adults, and a good number of adolescents as well, smoke cigarettes . . . and they also vote — or soon will," noted Professor Harvey M. Sapolsky of M.I.T.'s Political Science Department. This fact alone meant that there were significant political and economic obstacles to the most obvious, direct line of action: banning cigarettes. There are even intractable obstacles to such lesser measures as removing government subsidies to tobacco growers.

But some policy initiatives have been possible, and — though the reasons are probably quite unrelated to these initiatives — there is "some circumstantial evidence that the adverse consequences of cigarette smoking may be waning" in the U.S., according to Dr. Jeffrey E. Harris of the M.I.T. Department of Economics. The point is not that cigarette consumption has declined; it hasn't. But there has been an unanticipated technological change. Cigarettes are becoming safer; most of those consumed now have filters, and most have lower levels of tar and nicotine than 20 years ago. It's a technological response on the part of manufacturers that has only the most indirect relationship to government intervention.

While U.S. cigarette smoking has been levelling off during the past 20 years (and concentrating in fewer people, with more women and fewer men now indulging), cigarette consumption in France has continued to climb sharply — from 764 cigarettes per adult in 1974 to 2,068 in 1977. French anti-smoking campaigns have been ineffective. Jean-Francois Lacronique of the Departement de Santé Publique finds the management of cigarette smoking as intractable as the scientific dilemmas presented by nuclear power, genetic manipulation, vaccinations, and auto seat-belts.

The Capital Costs of Capital and Fuel

District heating and co-generation — the two systems are often interconnected — stirred a lively U.S.-French debate which rested almost entirely on economic issues: What is the capital cost of district heating and co-generation installations in comparison with the value of fuel to be saved?

The French tradition of centralized government seems to lead to understated capital costs — and therefore to confidence in and enthusiasm for both these technologies. An example is Grenoble, where nearly 40 per cent of the city's apartments, offices, and factories and many public buildings receive heat from central plants. Grenoble's heating company earned 4.6 per cent on its gross revenues in 1974, but that's recently fallen to less than 0.5 per cent, according to Hazel Ranninger of Grenoble's Institute Economique et Juridique de l'Energie; now, after years of service as a commercial enterprise, the company is struggling to live with a new set of expectations among its users, who see it as a public — rather than a private — service.

From the American perspective of Leon Glicksman of the M.I.T. Energy Laboratory, district heating is far less attractive: substantial fuel saving could come only from retrofitting of existing cities, he says. In densely populated central cities, the cost of a new district heating system would be "prohibitively high." Only in residential neighborhoods where population density is about 10,000 people per square mile could the retrofit cost make district heating competitive with conventional fossil fuels. But "massive capital investment" requirements are discouraging, and U.S. activity in planning new systems is "very limited," said Dr. Glicksman.

In Search of Technopoliticalagnosticians

In his opening address to the symposium, President Jerome B. Wiesner of M.I.T. added another complication to the confrontation between science and the political systems in which it works:

"I regard all societies as learning systems and judge them by how well they are organized to learn," Dr. Wiesner told the symposium. He concludes that the major task in helping social systems deal with modern complexity is "to improve the societal learning process." That explains his concern, he said, that a technologically-based society be "a dynamic system in a continuing state of change and evolution, continuously learning by experimenting with new technologies, new organizational forms, new relationships among its organizations and citizens."

Can we learn in time? As the symposium drew to an end Professor Kenneth Keniston of M.I.T.'s new Program in Science, Technology, and Society suggested that the world still distinguished too easily between scientists and policymakers, concentrates too clearly on that dualism, and tends to assign a very special role to the scientific elites on one side of it. Most of those at the meeting in Paris, said Dr. Keniston, were falling into this same trap by making neat separations between the technical and sociopolitical aspects of questions. He wished instead that the Paris conference had bred a new class of "technopoliticalagnosticians."

And we need also to remember, said someone at the cocktail party as the conference adjourned, that "perfect science would be the end of choice." — *J.M.* □

Breast Cancer: a Vote For Conservatism

When survival is considered as the criterion, the radical surgery often chosen for treating localized breast cancer in the U.S. is no more effective than more conservative simple mastectomies.

That conclusion, certain to add heat to a continuing medical controversy, comes from Maurice S. Fox, Professor of Genetics in the Department of Biology. It's the result of studies of a large number of med-

ical records completed while Dr. Fox was on sabbatical leave from M.I.T. working in the Harvard School of Public Health; the report appeared in the *Journal of the American Medical Association (February 2)*.

Dr. Fox's analysis showed that a simple mastectomy — removal of the breast itself — was at least as effective statistically as more radical surgery in women with localized disease; presently more than half the diagnosed cases of breast cancer are localized.

His figures also revealed a dramatic increase in the reported incidence of breast cancer since 1965; but the risk of dying from this disease has remained unchanged since 1940. The conventional explanation would hold that treatment has become more effective, presumably because the disease is being discovered earlier. But Dr. Fox thinks mis-diagnosis may be a factor, too: some of the surgical procedures are probably being invoked against a benign condition with symptoms similar to those of malignant disease which does not in fact require intervention. "It remains possible," he writes, "that much of the 'early' disease detected by screening would never manifest itself as malignant disease in a normal lifetime."

If all this presents internists with new ethical and clinical dilemmas, Dr. Fox is unperturbed. "Recognition that a dilemma exists is a prerequisite for progress," he says. □

A Primer on Eating

Gourmets and lovers of whipped cream and apple pie, take comfort: "There is no such thing as a 'fattening' food," says Dr. Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science.

But, of course, that's not the whole story. What Dr. Scrimshaw meant when he made that comment to Nancy Beach for the *New York Times Magazine* was this: the key issue is one's total calorie consumption. It doesn't matter whether your calories come concentrated in a small serving of a rich dessert or spread out in a larger helping of potatoes and pasta. "Any food eaten to caloric excess will make us gain weight."

So when he talks about diet Dr. Scrimshaw emphasizes calorie counts, not specific portions of specific foods.

And he also emphasizes variety as the simplest and surest way of achieving a well balanced diet without having to be an expert on vitamins, minerals, protein, carbohydrates, and trace elements. Variety has another advantage, too: it's the best protection against excesses of substances which are harmful in excess.

Two other shibboleths shattered by Dr. Scrimshaw:

□ Our appetite is not a good indicator of our nutritional needs. In today's cultural context, cravings for certain foods are more psychological than physiological in origin. That wasn't always true of the human condition, thinks Dr. Scrimshaw: "In the primitive hunter-gatherer societies," he explained, "the consumption of an enormous variety of foods was combined with a high level of physical activity," and that's clearly not true of most people today.

□ "The idea that all so-called 'natural' foods are safe is a myth," Dr. Scrimshaw said. There are all kinds of substances in products we accept without question as food — beans, nuts, fruits, and cheese — which "wouldn't pass the tests required of additives." So that becomes another argument for variety: don't overload your diet with any single food. — *J.M.* □

Surrounded by tall buildings, the steeple of Boston's venerable Old South Meeting House experiences wind gusts for which it was never designed. Now the structure is to be strengthened, and Maurice A. Reidy Engineers of Boston (under a National Park Service contract) came to M.I.T. for wind tunnel tests. Drahomir Lazar, a graduate student in aeronautics and astronautics, has the task of instrumenting a model of the Boston skyline in the Wright Brothers Wind Tunnel. (Photo: Calvin Campbell)

Fusion in Five Years?

A new, optimistic prediction on fusion power from Bruno Coppi, professor of physics:

Controlled thermonuclear ignition, an elusive goal in more than 20 years of scientific and technological research, may be demonstrated as soon as 1984.

The winner in the sweepstakes will be a compact fusion reactor burning radioactive tritium, a hydrogen isotope. Professor Coppi first presented the theory for such a compact machine — he called it "Ignitor" — in 1976. Since then, he says, larger fusion machines such as the torus at Princeton University have produced important experimental results which confirm his judgment that compact designs will lead to the goal of a fusion reaction quickly and at relatively low cost.

Dr. Coppi is associated with the Alcator fusion experiment at M.I.T.; it embodies many of the characteristics of high density and compactness which Dr. Coppi embraces, but it does not use tritium because it is conceived as a research tool and not as a production machine.

Dr. Coppi's optimistic prediction was made before a meeting of the M.I.T. Club of Washington on January 9. □

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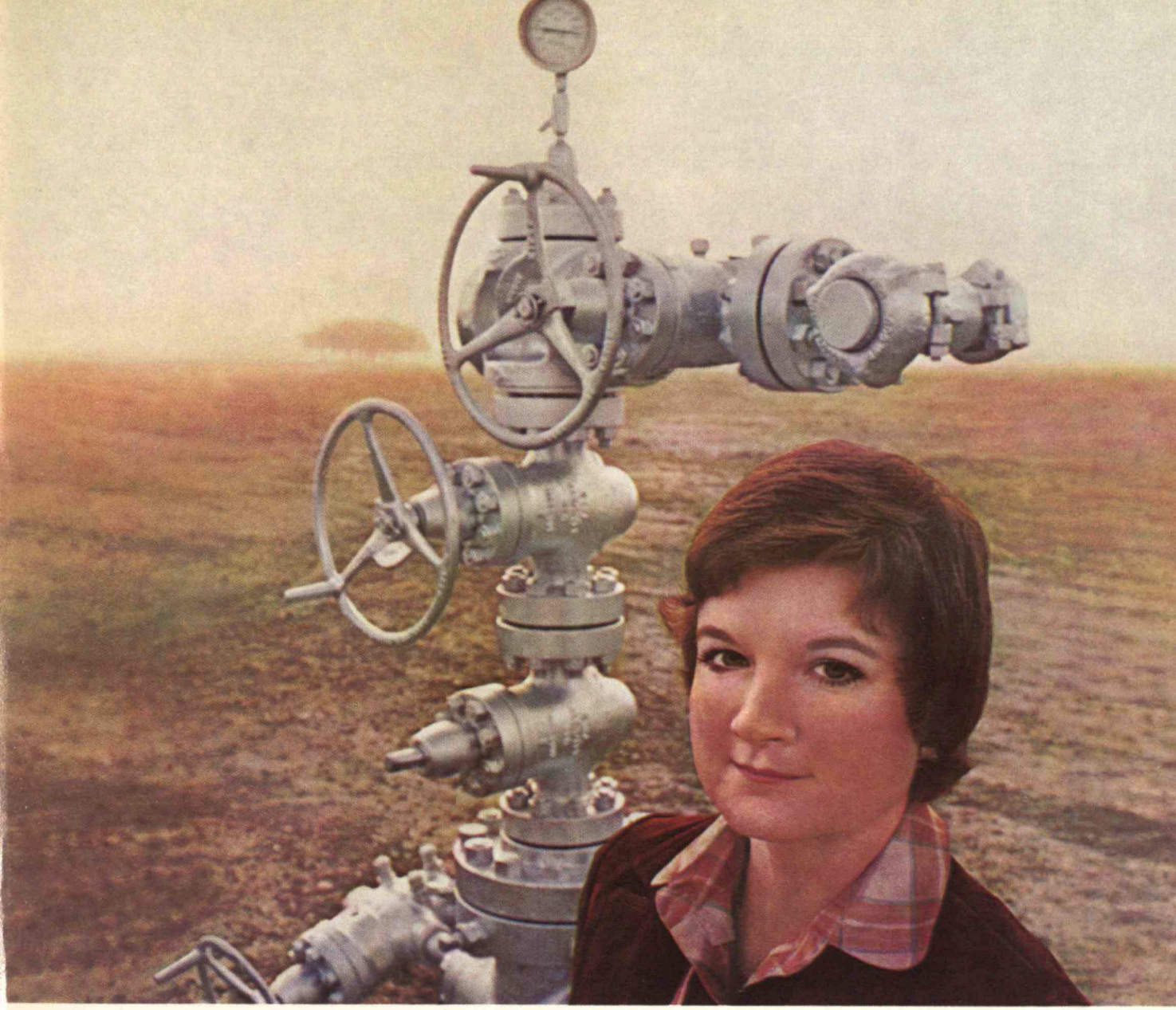

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